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J. F. DEEMS.

The appointment of Mr. Deems to the newly created position of General Superintendent of Motive Power of the Vanderbilt Lines is one which it is a pleasure to announce, not only because of the fitness of the selection, but because of the far-reaching and broad-minded policy of which the appointment is a part. It is not alone a recognition of the growing importance of motive power problems, it is a significant indication of appreciation of the possibilities of advantage to be had by drawing together to one general officer the engineering, operating and commercial responsibilities of the motive power branch of the operation of a combination of railroads. In such a policy the allied Vanderbilt roads inaugurate a plan which will bring to the owners results of the concentration of ownership, which could not otherwise be obtained. The widely different ideas of the individual officers of allied lines like these, as expressed in practice, result in large expenditures which might be saved by uniformity of construction and methods of handling motive power matters. No one can predict the value of this step to these roads. It is a business move which is entirely in accord with the spirit of the times and one which will, unquestionably, bring most important and far-reaching results similar to those obtained by concentration so often seen in connection with large industrial combinations.

J. F. DEEMS.

Some months ago the mechanical officers of the New York Central, the Lake Shore, the Big Four, Michigan Central, Boston & Albany, Nickel Plate, P. & L. E. and Lake Erie & Western—all closely related lines—formed an association to confer upon questions relating to equipment with a view of establishing uniform practice and avoiding the unnecessary differences in present construction which characterized the individual railroads, the underlying idea being to work toward a reduction of construction to a common system to be adopted by all. These roads operate 10,000 miles in a territory of the densest traffic; tney include 3,625 locomotives, 3,602 passenger and 148,105 otner cars. This organization, of which Mr. A. M. Waitt is Chairman and Mr. F. M. Whyte secretary, has already accomplished a number of standards and now has several important problems under way, such, for example, as the pooling of freight equipment. The appointment of Mr. Deems is an outgrowth of this plan and it places a general officer over the strictly Vanderbilt lines. In its scope and possibilities the position is unique in this country and it is believed that there is none like it in the world. The responsibilities of Mr. Deems will reach far beyond the material to the personnel. It is understood that he will direct the various motive power departments of these roads, which is a task requiring the best knowledge of the work, the most careful and accurate judgment and the widest experience.

Mr. Deems comes to his new office thoroughly understanding his problem and after an extended experience, which, in addition to his railroad work, includes the direction of next to the largest locomotive building establishment in the country. In this way he combines railroad and commercial experience, without which no one would attempt such responsibilities. There is probably no line of industry so greatly in need of the application of business principles than the part of railroad operation which deals with locomotives. The establishment of this office is, therefore, considered as the beginning of a new era in motive power matters and its effect upon the future cannot be estimated.

Mr. Deems is 46 years of age. He was born in Brownsville, Pennsylvania, and is a graduate of the South Western Institute of that State. At various times while obtaining his education he "taught school." His first railroad work began with his apprenticeship on the Baltimore & Ohio, where he later served as a machinist. About 15 years ago he went to the Chicago, Burlington & Quincy as a machinist in the shops

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at Beardstown, Ill. Eight months later he became gang foreman and then roundhouse foreman. His next step was to the position of roundhouse foreman at Galesburg, Ill., the most important division point on the road. He next returned to Beardstown as general foreman and was soon made master mechanic at Ottumwa, Ia. Then he went back to Beardstown in the same capacity, where he remained until called to succeed the late Joel West as master mechanic at West Burlington. It was here that he did his most important work on this road. He established piecework on a new basis and it spread from there all over the system. He has the faculty of discovering ability in young men, and it was this faculty which made him so strong on this road. Two years ago he was appointed to the position of assistant superintendent of motive power and soon succeeded Mr. Delano as superintendent of motive power. Ten months ago he was called to the position of general superintendent of the Schenectady Works of the American Locomotive Company, a position which he has filled with ability and success.

The success of Mr. Deems is the result of his ability and personality. He takes a personal interest in every man under him and the humblest day laborer is not beneath his notice. He has repeatedly said to the writer: "Humble work does not necessarily take from any man any element of manhood." He is always approachable and his office is always open to any subordinate of any degree who comes with a claim of injustice. While always accessible, genial and friendly, his experience is such that no workman can deceive him. With all these traits, authority and discipline do not suffer. In his article in our June number of last year he gave the following expression: "There is no authority worthy the name except that which secures voluntary service; there is no official dignity except that which is based on the love and respect of the subordinate for the superior, and if the railroads could to-day measure in dollars and cents the exact cost of this so-called authority or official dignity, they would probably find it a liability of much greater magnitude than they now realize."

A friend and associate in his work, who has been close to him for fifteen years, expressed the following view of the secret of the success of Mr. Deems:

"It is his absolute loyalty to his friends and his love for his work and his associates. This means all the men who are working for him, from the humblest to the highest. It comes from the heart—it is not 'put on,' he really means it. He treats the men under him always as a gentleman, never losing his temper, and he is happiest when he can do some personal favor for them. These many traits of character are what make him so popular with the men and such a good executive. He gets their voluntary support, and, after all, it is voluntary support that makes any man and not the support which is given for any other consideration."

The starting of large gas engines has presented an interesting problem. A newly developed oil engine built by the Campbell Gas Engine Company, of Halifax, England, is started by high-pressure burnt gases stored in a cylinder or bottle which is charged from the gas engine cylinder through a pipe connecting the storage cylinder with the combustion space of the engine cylinder. When an explosion takes place in the engine cylinder the pressure forces some of the burnt gases through the pipe into the storage bottle at a pressure of about 150 lbs. per square inch. A check valve holds this pressure in the bottle and its capacity is sufficient to start the engine three or four times without recharging. The recharging, however, takes place automatically whenever the engine is running. This engine is described in The Engineer, of London.

THE COMPOUND LOCOMOTIVE AND ITS DEVELOPMENT IN FRANCE.

BY A. HERDNER.

Assistant Chief Engineer of Motive Power and Rolling Stock.

SOUTHERN (MIDI) RAILWAYS OF FRANCE.

(*Concluded from Vol. LXXVI, Page 386.*)

An element evidently very important in compound locomotives, and which cannot be governed by any definite formula, and in the determination of which the sagacity of the designer necessarily plays an important part, is the ratio of volumes of high and low pressure cylinders that is best to adopt. However, the magnitude of this ratio must be considered as intimately related to the general data and design of the locomotive. About twelve years ago, at the time when the compound locomotive had become the live subject in France, I tried to treat the above question by calculation, and here is the method I have followed:

Let us consider steam admitted into a high-pressure cylinder of a compound locomotive with a given expansion under the absolute pressure P and exhausting from the low-pressure cylinder under the atmospheric pressure H. If the cylinder clearance and initial condensation be neglected it is evident that the manner of the steam utilization will be entirely defined by the three ratios:

K = ratio of the cylinder volumes.
f = degree of admission into high-pressure cylinder.
F = degree of admission into low-pressure cylinder.

Three equations being necessary to determine the three ratios, we can propose to satisfy ourselves with three distinct conditions that we choose among the most probable that will assure an economical or advantageous performance.

The first condition that comes to our mind consists in the realization of a given degree of total expansion, D, this being the ratio of initial volume of steam to the final volume. This condition is written as follows:

$$f = KD \qquad (1)$$

Another condition, which at present it does not appear advantageous to completely realize, but which answered well to the exigencies of the time, is expressed in the equation:

$$FK = 1 \qquad (2)$$

which signifies that there will be no fall in the pressure in the receiver, whose capacity, however, is supposed to be very large.

For the third condition we can assume that the work developed in each pair of cylinders is equal among them. From this we write the equation:

$$\mathrm{Log.}_e \frac{F}{f} = \frac{1}{KF} - \frac{hk}{Pf} \qquad (3)$$

But it may be more interesting to ascertain rather than the equality of work the equality of maximum forces to which the parts of transmission of the propelling mechanism are subjected. In that case the equation (3) can be substituted by the following:

$$\frac{h}{P} K^2 F + K(F - f) - f = 0 \qquad (4)$$

Finally we can simply propose to realize the equality of degrees of admission in each of the two cylinders; then the third condition can be expressed as follows:

$$F = f \qquad (5)$$

The determination of the correlative values of K, f, F will result, then, according to the choice that will be made from among the last three expressions, from the simultaneous resolution of one of the groups of the following equations: (1, 2, 3), (1, 2, 4), (1, 2, 5).

Geometrically the problem will consist (see Fig. 5) in dividing a combined steam diagram A B C D E by a parallel line I H to A B and E D, and this is what would result accordingly: Area ABHI = Area IHCDE, or AI × IH = IE × ED, or finally $(IH)^2 = AB \times ED$.

When it concerns an engine with a variable expansion, and in particular a locomotive, the method that we have just indicated can evidently be applied only to the normal position of the lever; that is to say, to the working cut-off in the cylinders. For any other position of the lever, K being determined and f becoming an independent variable, we can, nevertheless, propose to establish between f and F a certain relation destined to derive, for all positions of the reverse lever, the benefit of one or the other of the last two conditions that have been sought for the normal position of the reverse lever. If it is considered that condition (5) does not present any interest unless it can be satisfied for all degrees of admission, we are thus led to consider five different solutions that can be represented by the following symbols:

$$\frac{1,\,2,\,3,}{2} \quad \frac{1,\,2,\,3,}{3} \quad \frac{1,\,2,\,4,}{2} \quad \frac{1,\,2,\,4,}{4} \quad \frac{1,\,2,\,5,}{5}$$

and to several which correspond, as far as the distribution is concerned, to arrangements that were and are yet actually applied.

The study of these combinations, not coming entirely within the scope of this article, and presenting to-day an interest rather retrospective, we will limit ourselves to indicating a few numerical results obtained by means of our formulæ for the normal position of the reverse lever:

	K	f	F
Equality of work	1.67	0.334	0.599
Equality of maximum forces	1.96	0.392	0.509
Equality of admissions	2.24	0.447	0.447

The examination of the above formulæ shows that if all things are otherwise equal, P increases the values of K corresponding to the equality of forces, or slightly diminishes the equality of work, while the values corresponding to the equality of admissions remain invariable. If all things are otherwise equal and the total expansion is increased, the values found for K increase quite rapidly. In particular, if the expansion is sufficiently prolonged to have the steam exhaust at the atmospheric pressure the three values for K are intermixed in such a manner that the quality of work, equality of forces and that of admissions are realized simultaneously. In practice it will be admitted that by increasing P there should be a corresponding increase in the total degree of expansion in such a manner that there should be very nearly

$$PD = \text{constant.}$$

Let us consider, in this hypothesis, the case where P = 15 kilograms (15 kilograms is equivalent to 213.34 lbs.) pressure per square inch, and, consequently, $D = \frac{1}{6.25}$. The values of K, f and F will then become the following:

	K	f	F
Equality of work	1.88	0.300	0.532
Equality of maximum forces	2.23	0.356	0.448
Equality of admissions	2.50	0.400	0.400

Thus, as we have already remarked, experience has shown that a moderate fall of pressure in the receiver is not only without disadvantage, but actually presents a real advantage. Instead of expressing that this fall of pressure is naught, we could perhaps be led to assume that it has a determined value, c; equation (2), above evolved, can be now replaced by the following:

$$Pf - \frac{Pf}{Kf} = C \qquad \text{(2 bis)}$$

Let us take as before P = 15 kilograms and $D = \frac{1}{6.25}$, and we will make c = 1 kilogram (1 kilogram = 14.22 lbs. per square inch). The values formed under these conditions for these three ratios are those indicated below:

	K	f	F
Equality of work	2.28	0.365	0.537
Equality of maximum forces	2.50	0.400	0.480
Equality of admissions	2.70	0.433	0.433

Although the above figures, taken as a whole, approach very nearly the coefficients actually employed in practice, they cannot of course serve any other purpose than a simple indication.

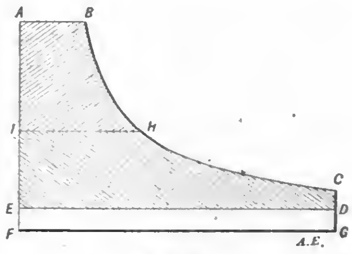


FIG. 5.

We believe, however, to be able to make from the above the following legitimate conclusion: *First, that for higher values of initial boiler pressure it is best to employ greater values for K; second, that the values attributed to K should increase with the allowable theoretical increase of the fall of pressure in the receiver; third, that the condition of the equality of work is that which gives the least values for K; fourth, and finally, that the condition of the equality of degrees of admissions is that which allows us to adopt for K the greatest values.*

It is explained from the above why—for the four-cylinder locomotives of the first and second category, in which the steam distribution in each pair of cylinders is governed by a common valve or by two valves mounted on one valve stem (the tandem compound)—the values for K were generally made relatively high. It is thus that we find in the locomotives of the Plant System of Railways and the one of the Wisconsin Central (proposed), to cite only the most recent examples, the values for K equal to 2.77 and to 2.70 respectively.

It is not to be understood that the equality of admission in these locomotives is to be an inevitable consequence of their style of construction. [Because of having one common valve for one high and one low pressure cylinder.—Editor.] The high and low pressure laps on those valves need not necessarily be equal and a slight difference, which actually exists, of ⅛ in. in the Vauclain compound locomotive for the Plant System of Railways and about 3-32 in. in the Wisconsin Central Railway locomotive, is perfectly allowable. But since the sum of the lap and linear advance of admission is always the same for both cylinders, these differences are necessarily very limited in practice.

It is evident that a four-cylinder compound locomotive, like the one of Mr. Webb, in which K = 1.867, could not adapt itself to a similar distribution. Mr. Webb has correspondingly arranged his valves on two separate valve rods connected with each other by a third horizontal lever with unequal arms. The valves have thus two different travels, but as it is the throw of the eccentric that gives the actual movement to the valve, which is always the same for both valves, it can easily be conceived that a similar interdependence may be considered disadvantageous.

Mr. Von Borries, by employing the Walschaert valve motion with two pendulums, manages to give to his high and low pressure valves two different travels, both through the amplitude of the pendulum governed by the stroke and the throw of the eccentric, which give the actual travel to each one of them. Elegant as this solution may appear, t is nevertheless easy to understand that because of the arrangement of the

mechanism employed, these two elements of the valve distribution are geometrically combined in such a manner that they cannot be governed independently of each other, or for each of the two valves under consideration in particular.

The use of four valve motions governed by a single reversing mechanism seems to offer, in this respect, a much larger latitude in the sense that the choice of the most proper elements to assure a good steam distribution is only limited by considering the different positions of the reverse lever.

But all these solutions present one common disadvantage, resulting from the fact that all the different phases of the steam distribution in the low pressure cylinder, as well as those in the high-pressure cylinder, are entirely determined, whatever the speed may be, by the position of the reverse lever, that the amount of work to be furnished has led the engineer to adopt. Moreover, if we stop to consider, all other things being otherwise equal, how much the speed influences the shape of the steam diagram taken by a steam indicator, it will be admitted that the most complete and the most satisfactory solution concerning the steam utilization is the one adopted at the very first by Mr. de Glehn, and which consists in the division of the reversing gear. Thanks to this division, the engineer, without changing the admission in the H. P. cylinder, and consequently without modifying appreciably the quantity of steam consumed per stroke, can vary not only all the phases of the steam expansion in the L. P. cylinder, simultaneously as to the duration and importance of pressures in play, but also the governing pressure in the receiver, and consequently the back pressure in the high pressure cylinder. He is thus in a position even to combine between them whatever may be the amount of work to be developed, or whatever may be the speed at which that work is to be furnished, the degrees of admissions in the H. P. and L. P. cylinders found most advantageous—that is to say, those that will allow him to produce, with the same amount of steam consumed, the greatest quantity of work. We do not forget that this arrangement, which is mostly reproached for its complications, has often been criticised, especially in Germany and America. We confess not to understand the importance which was often attributed to these criticisms. The double reversing gear cannot appreciably increase the initial cost of the locomotive, nor the cost of repairs, and the advantages it affords, indisputable indeed, as far as economy and power developing is concerned, could have been very small indeed to compensate for so little an increase in cost. It will be objected that it leaves to the engineer too large an initiative, which he might abuse in combining irrationally the different degrees of admissions. This is not our opinion. We have, on the contrary, always noted that those interested in getting the most work out of their engine, interested in the economy of fuel, who year after year operate the same locomotive, and who have frequent occasions to mutually exchange observations, have come to adopt, in a measure, inevitably, even in the absence of comprehensive instructions, and oftentimes in spite of them, a way of running their engines most conforming to their interests, and consequently the most advantageous and most economical.

It has often been said that the compound locomotive is more susceptible to a poor steam distribution than the simple expansion locomotive. This is correct, and we cannot exercise too much care to especially note that in no case should the final pressure of the steam, compressed in the cylinder clearance space, particularly in the H. P. cylinder, attain so high a pressure as to be likely to interfere with the free movement of the engine.

Let us designate by U and u the volumes occupied by the steam at the beginning and the end of the period of compression. The final pressure, p, of the steam compressed in the high pressure cylinders will be expressed in the following equation:

$$P = \frac{U}{u} \times \frac{Pf}{Kf}$$

Where, after equation (2 bis)

$$P = \frac{U}{u} \times (Pf - c)$$

Three means are, therefore, at the disposal of the designer to reduce the value of P for the given values of P and f. 1st: u can be increased, which will necessitate principally increasing the cylinder clearance and incidentally the linear advance of the values.

2nd: U can be decreased by employing negative laps.

3rd: Finally, c, which, as is shown, represents the fall of pressure in the receiver, can be increased by giving longer admission to the lower pressure cylinder.

In practice two of the means are generally resorted to at the same time, and sometimes even all the three means; but as they all enter in very variable quantities, it results for the steam distribution in use in quite appreciable differences.

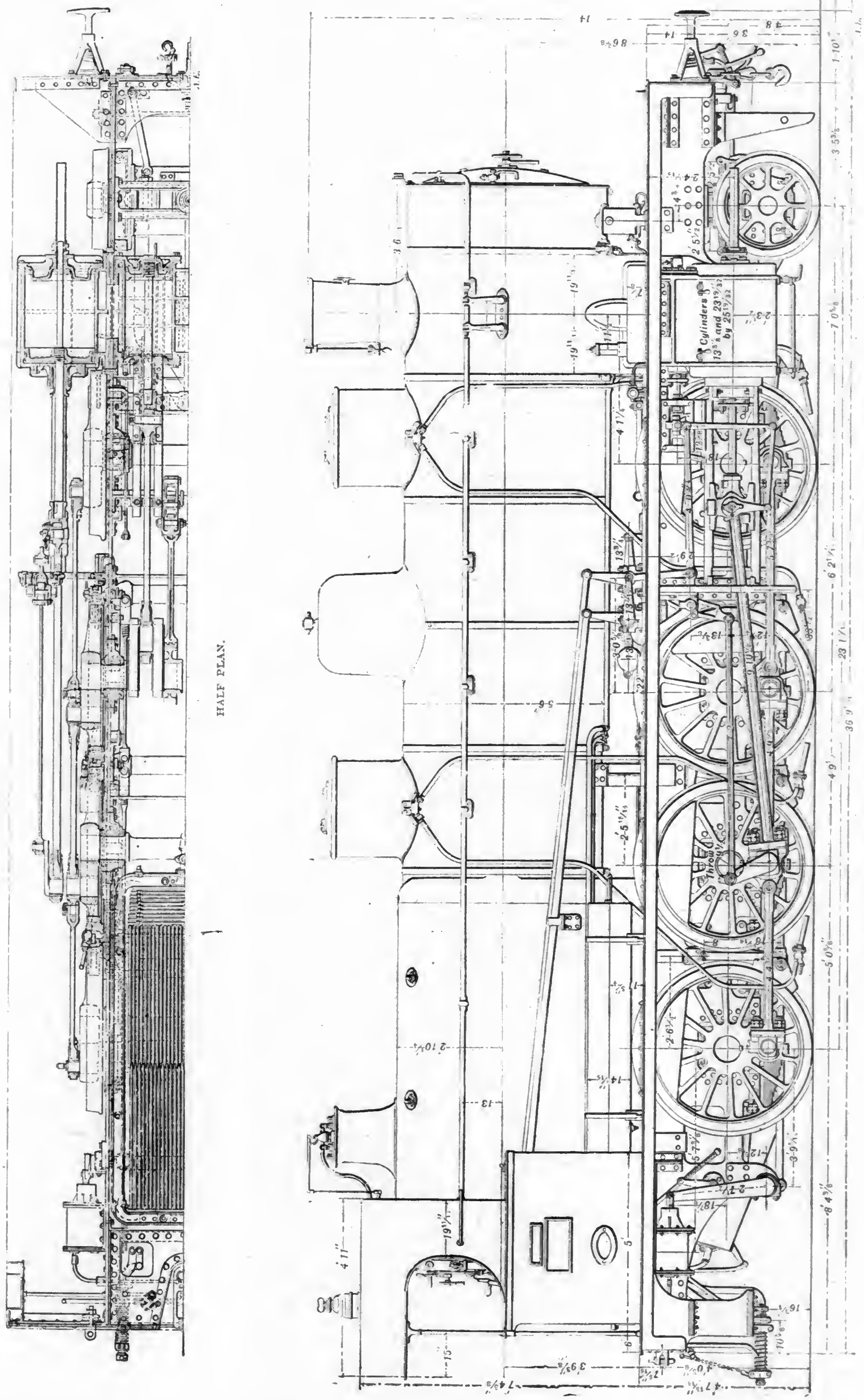
Mr. Von Borries, who has always avoided an excessive fall of pressure in the receiver, gives preference to the employment of the first two means. In this regard, he has established certain definite rules which consist in allowing a cylinder clearance of 12 per cent. of the cylinder volume, of inside negative laps equal to 20 per cent.—and even 25 per cent.—of the inside lap, and of linear advances of about 10 per cent. of the outside lap, the whole with a value of K not exceeding 2.25 and the valve gears arranged for a difference of about 0.10 between f and F for the usual cut-offs. These conditions, however, seem to apply mostly to the two-cylinder compounds having an initial pressure not exceeding 184.9 lbs.

The Northern Railways have also till quite recently allowed cylinder clearances of about 12 per cent. of the cylinder volume, but the inside negative laps of its valves were much less. On the other hand, the fall of pressure, relatively greater, that occurred in the receiver, did not show any appreciable disadvantage, especially at high speeds, because of having the valve gears entirely independent and left to the engineer all possibility to regulate the magnitude of this fall of pressure, according to the work to be done.

On the Paris, Lyons and Mediterranean Railways, where inside negative laps are not allowable, the third of the above named means is especially employed to reduce the final pressure of compression. This accounts for the special arrangement of the valve motions adopted by this company and which are made interdependent in such a manner as to mechanically assure a constant and prolonged admission in the lower pressure cylinders. Finally, on the Eastern Railways of France, where all three of the above means are made use of, it seems nevertheless that a certain preference is given to the first of them, since on its last built locomotives the cylinder clearance in the high pressure cylinders is as high as 20 per cent. of the cylinder volume. For the low pressure cylinders, which with reference to compressions are very much analogous to the cylinders of simple expansion locomotives,—a cylinder clearance of 7 per cent. to 8 per cent. of the cylinder volume can be used, like that in the simple engine, and with valves set for inside lap line in line or very small negative laps. In any event whenever an engine is designed to work with a very low pressure in the receiver, it may even be desirable to increase the above two elements.

Which among the diverse methods employed—all evidently being of a nature to insure a free steaming locomotive—are those which at the same time give the most economic performance of the steam consumed?

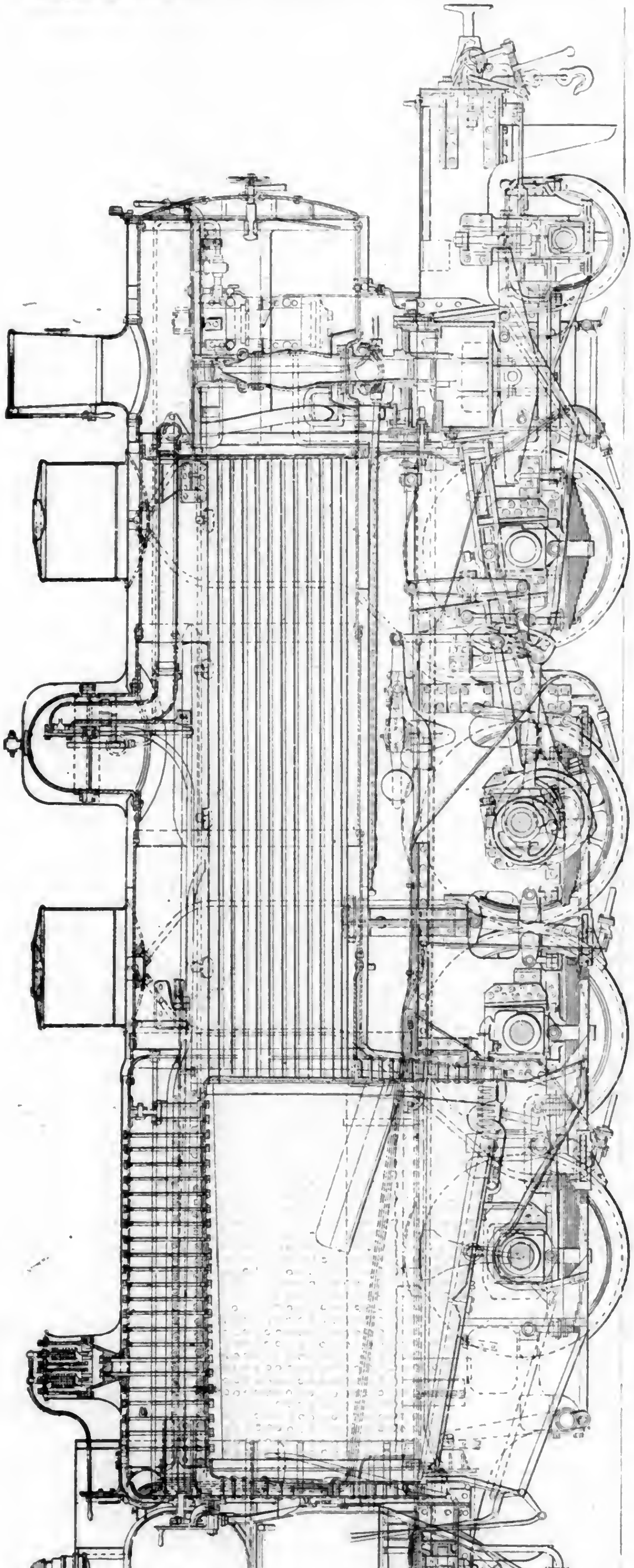
This question is rather difficult to answer *a priori*, and comparative experiences are only misleading. But what appears to us beyond doubt is that the common steam distributions for both high and low pressure cylinders are those that,

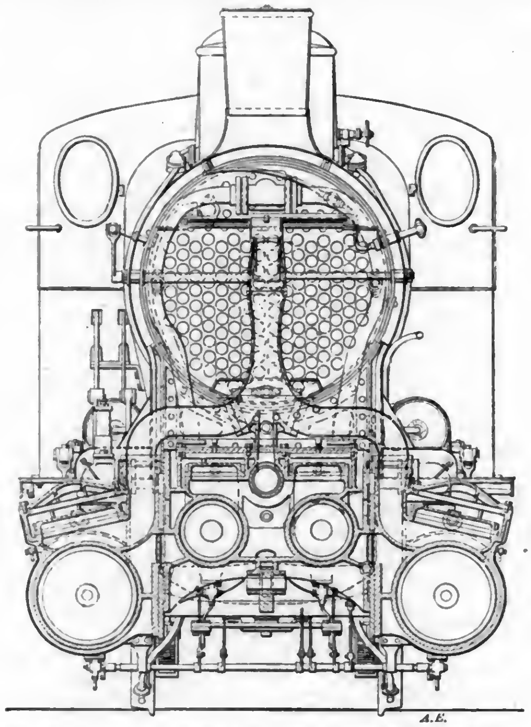


HALF PLAN.

FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.—SOUTHERN RAILWAYS OF FRANCE.

2—8—0 TYPE.





FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—SOUTHERN RAILWAYS OF FRANCE.

because of the lesser number of elements that can be chosen by the designer, are least adaptable to the realization of the conditions most favorable to the best utilization of the steam at all positions of the reverse lever. The use of four distinct valves governed by a single reversing gear permit the designer to choose in the largest measure, among the means above indicated, those that appear to him most advantageous to regulate the compression phases. But when in this regulation the considerable influence of the speed is considered, whose effect may be equivalent to an increase of the initial volume U of the compressed steam, it is indispensable, in order to prevent the final pressure p from attaining in certain cases an excessive value, to be able to increase the value of c or the fall of pressure in the receiver.

In other words, this result cannot be obtained in practice unless we reserve for ourselves the means of varying the degree of admission F independently of the admission f. In increasing F, not only the compression in the H. P. cylinder is reduced, but also that in the L. P. cylinder; it is with this fact that our engineers have become acquainted, more or less instinctively, inasmuch as they have got into the habit of giving, if not the ratio $\frac{f}{F}$, at least to the difference F — f, increasing values with the increase in speeds they wish to realize.

The description we have given above of the diverse methods employed to avoid excessive compressions shows clearly that the four-cylinder compound, although a more recent locomotive, has not benefited in a measure we were tempted to expect from the experience obtained previously with the two-cylinder compound in other countries. The four-cylinder compound has been developed for its own sake. The first locomotives (as the first two-cylinder compound locomotives) have been reproached in not being able to make speed, and it must be admitted that a certain number of locomotives, built after the time when the rules of Mr. Von Borries were already known, deserved this reproach, though in a very small degree. The splendid tests made by Mr. Barbier of the Northern Railways in 1897 under the direction of Mr. Du Bousquet, have enabled us to improve certain arrangements most adaptable to assure

to the four-cylinder compound locomotive a very free running and have given a most interesting series of results. Mr. Barbier, and Mr. Von Borries agree in their conclusions as to the advantage of large cylinder clearances and appropriate inside negative lap. Mr. Barbier recommends in addition the increase of the areas of steam, the volumes of steam chests, the section of the admission and exhaust ports and in general the suppression of every obstacle to the free circulation of the steam.

The experiments previously made by the Western Railways brought out the importance of the advantage in increasing the volume of the steam chests and the section of the steam pipes.

The splendid work recently performed by locomotive No. 2645 of the Northern Railways, which with a train, back of tender, of 196 tons, has covered a distance of 120 miles, between Paris and Arras, in 112 minutes—that is, at an average speed of 64.4 miles per hour—shows that the results sought have been attained in the largest possible measure. This performance is so much more remarkable from the fact that the long grades of ½ per cent. have been covered at a speed of 75 miles per hour, and even higher, and that higher speeds have not been made on down grades on account of train being ahead of time.

The four-cylinder compound locomotives which are at present employed in France, a great number of which have been designed by Mr. de Glehn, or built on the same principles, can be classified into five principal types:

(1) Fast passenger locomotives, 8-wheel, or generally known as the "American" type. This type of engine is at present employed by all railway companies, as well as by the State railways.

(2) Fast passenger locomotives of the "Atlantic" type. At present only the Northern Railways possess this type of locomotive, series Nos. 2641 and 2660. Similar locomotives are being built for the Southern and Eastern Railways and still other, more powerful, for the Paris-Orleans Railways.

(3) The 10-wheel type, first put in service in 1896 by the Southern Railways and which has since been reproduced by other railway companies and State railways with more or less important modifications, but which do not alter its general aspect.

(4) 8-wheel connected locomotives of the Paris, Lyons and Mediterranean Railways, a number of which have been transformed into 10-wheelers (of the type 3) by substituting a 4-wheel truck in place of the forward driver.

(5) The "Consolidation" type engine built in 1901 for the Southern Railways and of which there are so far but two locomotives, Nos. 4001 and 4002.

The first four types above defined are sufficiently known today to call for a more detailed description; but agreeable to the readers of the American Engineer and Railroad Journal, we attach to this article a photograph, principal data and a few general drawings of the engine No. 4001 of the Southern Railways.

These locomotives haul trains of 220 tons on 3.3 per cent. grades on the Beziers to Neussargues division with an equivalent kilometric consumption of steam and of slightly inferior kilometric consumption of coal than our older 8-wheel coupled locomotives, single expansion, and which cannot haul more than 159.8 tons on the same grades.

PRINCIPAL DATA OF LOCOMOTIVES NOS. 4001 AND 4002.
Southern Railways of France.

Boiler pressure	213.35 lbs. per sq. in.
Grate area	31 sq. ft.
Heating surface—	
Firebox	170 sq. ft.
Tubes	2,586 sq. ft.
Total	2,756 sq. ft.
Serve Tubes—	
Number	148
Outside diameter	3 ins.
Thickness	7-64 in.
Length between flue sheets	14 ft. 1 5-16 in.
Inside mean diameter of boiler	4 ft 11 9-16 ins.
Cylinders—	
Diameter of high pressure cylinder	15⅜ ins.
Diameter of low pressure cylinder	23 19-32 ins.
Stroke	25 19-32 ins.
Ratio of low to high pressure cylinder	2.360
Ratio of volume of receiver to that of both high pressure cylinders	1.740
Diameter of driving wheels	55⅛ ins.
Diameter of pony truck wheels	33½ ins.
Wheel base, distance from—	
Pony truck to forward driving axle	7 ft. ⅝ in.
Forward driving axle to H. P. main axle	6 ft. 2 13-16 ins.
H. P. main axle to L. P. main axle	4 ft. 9½ ins.
L. P. main axle to rear axle	5 ft. ⅝ in.
Total wheel base	23 ft. 1 9-16 ins.
Weight of locomotive light	142,340 lbs.
Weight in working order—	
First axle	15,400 lbs.
Second axle	35,530 lbs.
Third axle	35,530 lbs.
Fourth axle	35,530 lbs.
Fifth axle	35,530 lbs.
Total	157,520 lbs.
Adhesive weight	142,120 lbs.
Total length of engine	36 ft. 10 5-16 ins.

Editor's Note.—We are indebted to Mr. Charles M. Muchnic, formerly mechanical engineer of the Denver & Rio Grande Railway, for the translation of Mr. Herdner's article.

STARVING INJECTORS.

It is not unusual for a large locomotive injector to throw 3,500 to 4,500 gallons of water into a locomotive boiler in an hour and yet such delivery is expected to be provided for through pipes no larger than were formerly used in connection with injectors which would deliver but 2,000 gallons in that time.

While great progress has been made in connection with other parts of locomotives, the injector connections have not been given the attention which they deserve and the locomotive has fairly outgrown them. In many cases the old standards have remained the same for about 20 years, notwithstanding the fact that locomotives have been more than doubled in capacity in that time. With increased boiler capacity and high steam pressure it is necessary to use injectors which will deliver a great deal more water than that which formerly sufficed, and the time has come for a radical change in this practice.

There seems to be no reason why at least 3-in. smooth-bore hose should not be used to connect with the tender tank. With this a free opening of 2⅝ ins. may be obtained in the fitting. A strainer at the valve in the tank well may be used and the conical strainer in the pipe removed. This would permit of using much larger channels for the water to the great relief of the injectors.

It is not enough to enlarge the suction side alone, the delivery pipes and checks also appear to need attention. The duplex check fitting supplied by the Brooks Works, which is shown in many locomotive engravings in this journal, seems to be a very good device, because it delivers all the water on one side of the boiler, which seems to be better practice than to enter it in two places and in two directions. This, however, is not the main point of this criticism. The free and unobstructed opening for the water is what is needed. A check that will lift but 1-16 in. for a No. 10 injector connected by a 2¼ in. pipe is not sufficient, yet this has been found in a recently built locomotive. Such an injector needs at least an even equivalent to a 2-in. hole. In one of the reports presented to the Master Mechanics' Association last June the following suggestions occur:

"As the water evaporation is heavy, a good inlet from tank to injector should be provided. A majority of the manufacturers prefer the following sizes of feed-pipe in connection with the different-sized injectors:

"No. 8, not less than 2 ins. internal diameter.

"Nos. 9 and 10, not less than 2½ ins. internal diameter.

"Nos. 11 and 12, not less than 3 ins. internal diameter.

Since this criticism was prepared a paper on this subject has been read by Mr. W. R. Park before the New England Railroad Club, stating that recently fittings have been called for to provide for injectors delivering from 5,800 to 6,000 gals. per hour.

ORE CARS, 80,000 POUNDS CAPACITY.

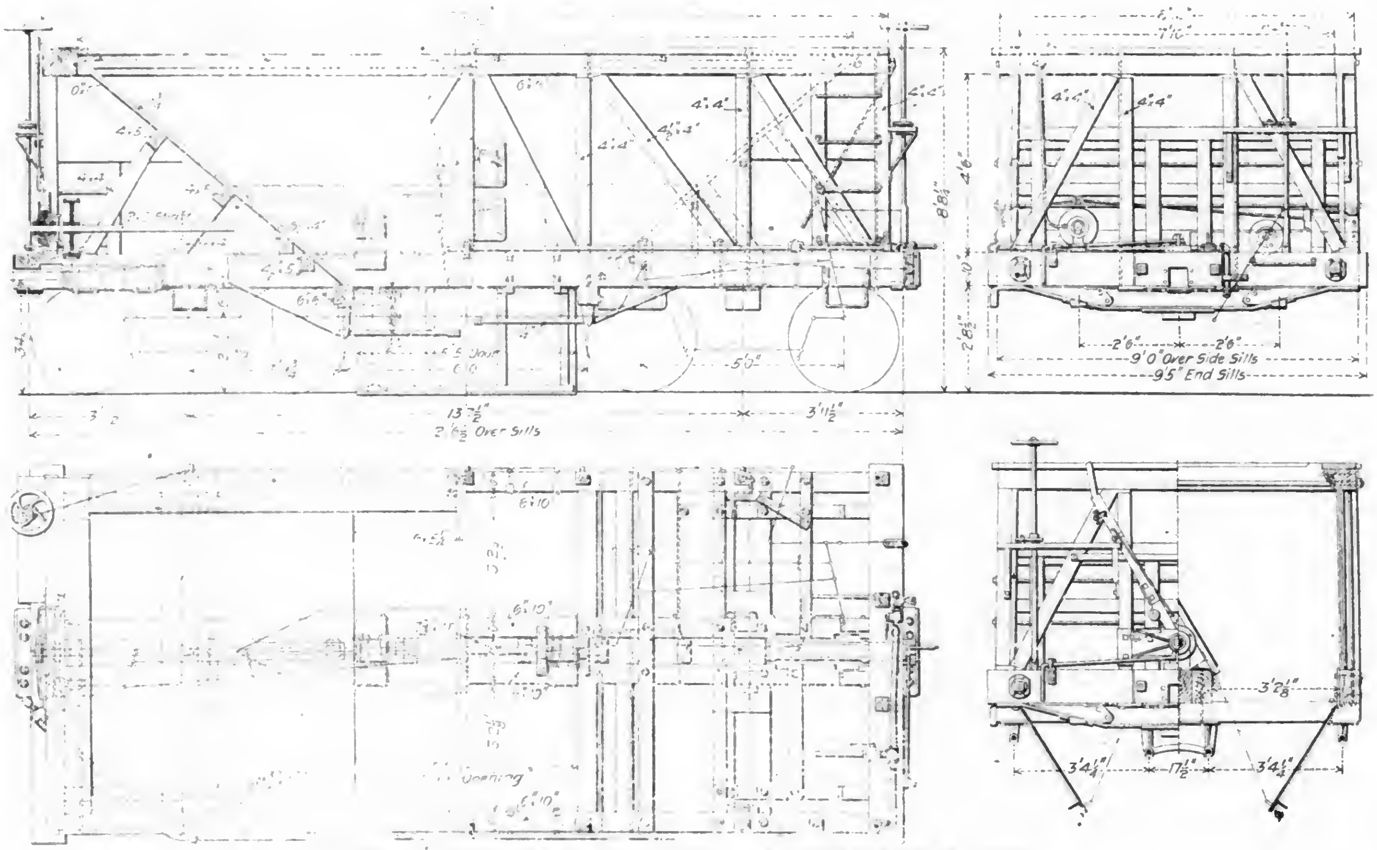
CHICAGO & NORTHWESTERN RAILWAY.

These ore cars were designed by Mr. C. A. Schroyer, superintendent of the car department of the Chicago & Northwestern, to meet the special requirements of the large ore traffic of that road.

Their principal feature is in the very large door opening, 5 ft. 6 ins. long and 3 ft. 2 ins. wide, on each side of the car. The doors close against the lower faces of the sills and the hopper surfaces are at the ends only. When the doors are opened they drop against the rail heads and deposit the load to the ore pockets from between the rails. Unless the door openings are large the ore bridges over them and it is difficult to get the load out. To assist in guarding against this difficulty the car sides slope inwardly slightly toward the top. This bridging is particularly troublesome with high manganese ores, which cement together and are sticky. In this construction there is only about 20 ins. of obstruction at the center sills. Four "poke holes" are provided in each side for inserting bars to loosen the load when necessary. A shaft extends through the car at the center to operate the doors and it is turned by a lever and ratchet at the end.

The body bolsters are of Z bars. The draft gear is of the tandem spring type and is placed between the center sills where the draft is direct. The sills are four in number, 6 x 10 ins. in section and all of them trussed. In a car but 20 ft. long this construction presents a stiff backbone for pulling and buffing stresses. The officers of this road do not see any advantage in steel construction for cars of this length.

About 650 of these cars are now in service. After two years' service they weigh 28,000 lbs. and are carrying regularly from 80,000 to 100,000 lbs. of ore. They are mounted on Haskell & Barker trucks.



ORE CAR, 80,000 LBS. CAPACITY—CHICAGO & NORTHWESTERN RAILWAY.

It has been erroneously reported that Mr. A. M. Waitt has resigned as superintendent of motive power and rolling stock of the New York Central & Hudson River Railroad. We are glad to state, upon the authority of Mr. Waitt, that he has not resigned.

The total heating surface of the nineteen boilers of the Norddeutscher Lloyds' twin screw steamship "Kaiser Wilhelm II." is 107,643 sq. ft, and the grate area 3,121 sq. ft. The boiler pressure will be 225 lbs. and the engineer will develop 40,000 indicated horse power.

In a recent issue of *The Autocar*, London, it was stated that if automobiles are ever to be anytning but toys for mad millionaires—which they are at present—the makers will have to devote their attention to the production of vehicles that will take the place of cabs and carriages, and that will not break down continually or cost a small fortune to keep in repair.

F. W. WEBB.

It is announced that Mr. F. W. Webb has asked to be allowed to retire from his activities as chief mechanical engineer of the London & North Western Railway, after 52 years of service. He entered the Crewe Works in 1851 and with the exception of a short interval has been there ever since, and during this time has built about 4,000 locomotives. He is in charge of 3,000 locomotives and in connection with his work has developed a large number of improvements invented by himself. Among other improvements, he is said to have been the first to use steel boiler shells. In 1878 he changed an old Trevithick engine into a compound and in 1882 built one to his own design. He has been a consistent advocate of compounding, and seven types of compounds of his design are now running on the London & North Western. His salary, according to *The Engineer*, from which these facts are taken, is $35,000 per year, that of his predecessor Mr. Ramsbottom, was $25,000 per year. This fact is commented upon elsewhere in this issue.

NEW LOCOMOTIVE SHOP.

READING, PA.

PHILADELPHIA & READING RAILWAY.

I.

GENERAL DESCRIPTION.

The new locomotive shops of this road at Reading, Pa., are the most extensive as to size of buildings in this country. Reading is the natural geographical center of the road, and of 1,500 miles of track no part is more than 150 miles from this point. The old shops were built in 1850, in James Millholland's time, and numerous additions have been made, resulting in the usual rambling plant cut up by streets, which was very inconvenient in handling material and work. It could have been put into shape to meet the needs of the next ten years, but instead of doing this a portion of a large tract of land north of the union station was utilized, where the possibilities of endwise extension are unlimited. The old shops will be abandoned. This new location is near the car shops and is favorable for a central power plant for driving both locomotive and car shops and furnishing all the lighting required by the company in Reading.

Capacity.—The shops were originally intended to repair 750 locomotives, but the entire equipment of the road, now numbering 1,000 locomotives, will be maintained here. At several outlying points small shops will be maintained for light repairs, such as are ordinarily made in roundhouses. I is intended to put all of the locomotives through the shops once in every eighteen months, which will require turning out 56 per month. This includes general repairs, boilers, tanks, foundry, pattern and smith shop work. The erecting shop has 70 pits and is intended to provide track room for 70 locomotives undergoing general repairs at one time. Of course the rapidity with which they will be turned out will depend upon the machine and other departments. The car shops are separate, but in the same tract of land and also on the west side of the main line. The land owned by the company in this section of the city is in a valley and lies on both sides of the main line. It is a long and relatively narrow tract. When in complete working order about 2,000 men will be required in the locomotive department, and there are already 800 men in the car repair shops.

The Ground Plan.—For such a large plant the arrangement is compact and the plan was worked out to group work of similar character together in order to reduce to a minimum the distance through which material and parts must be carried. It will be noted that there is no thoroughfare between the buildings from one side of the plant to the other and that the boiler shop joins the southwest corner of the erecting shop. The reason for this is that a thoroughfare could not be used at this point, as the west line of the shop buildings lies close to a 12-ft. wall at the top of which is the street. The buildings are not placed too close together for good natural lighting. They are very large and substantial in construction, built of brick of a handsome dark red color, upon a skeleton frame of steel.

The locomotive shop is arranged on the transverse track plan, with two outside bays, with 35 pits in each, each bay being 70 ft. in width, with the machine shop, 60 ft. in width, between them. To get locomotives into and out of the shop two 65-ft. turntables with concrete pits are employed at the northeast and southeast corners. This avoids the necessity of a transfer table and provides a safeguard against tying up the shop by the failure or breakdown of a single turntable. The locomotives, once in the shop, are handled by cranes, the crane service being excellent, and in fact a feature of the entire plant in all departments.

A glance at the ground plan shows the care which was taken to provide as far as possible for straight-line movements of material. An excellent example of this is seen in the location of the boiler shop, already referred to, which is such that the 35-ton cranes of the west bay of the erecting shop may run into the boiler shop, or, in other words, the 35-ton boiler-shop crane can be run into the erecting shop. It will be noticed that a track runs through the boiler shop, another one from the storage yard north of the locomotive shop through the center of the machine shop and storehouse and that all the large buildings are connected to the service tracks by turntables. The forge and smith shops have their east wall in line with that of the locomotive shop and the storehouse is placed between the boiler and forge shops, which is as convenient an arrangement as could be made. The foundry is further removed to the eastward of the forge shops and the carpenter and pattern shop are immediately north of the foundry. Extensions may be made to any or all of the buildings by building on to their ends.

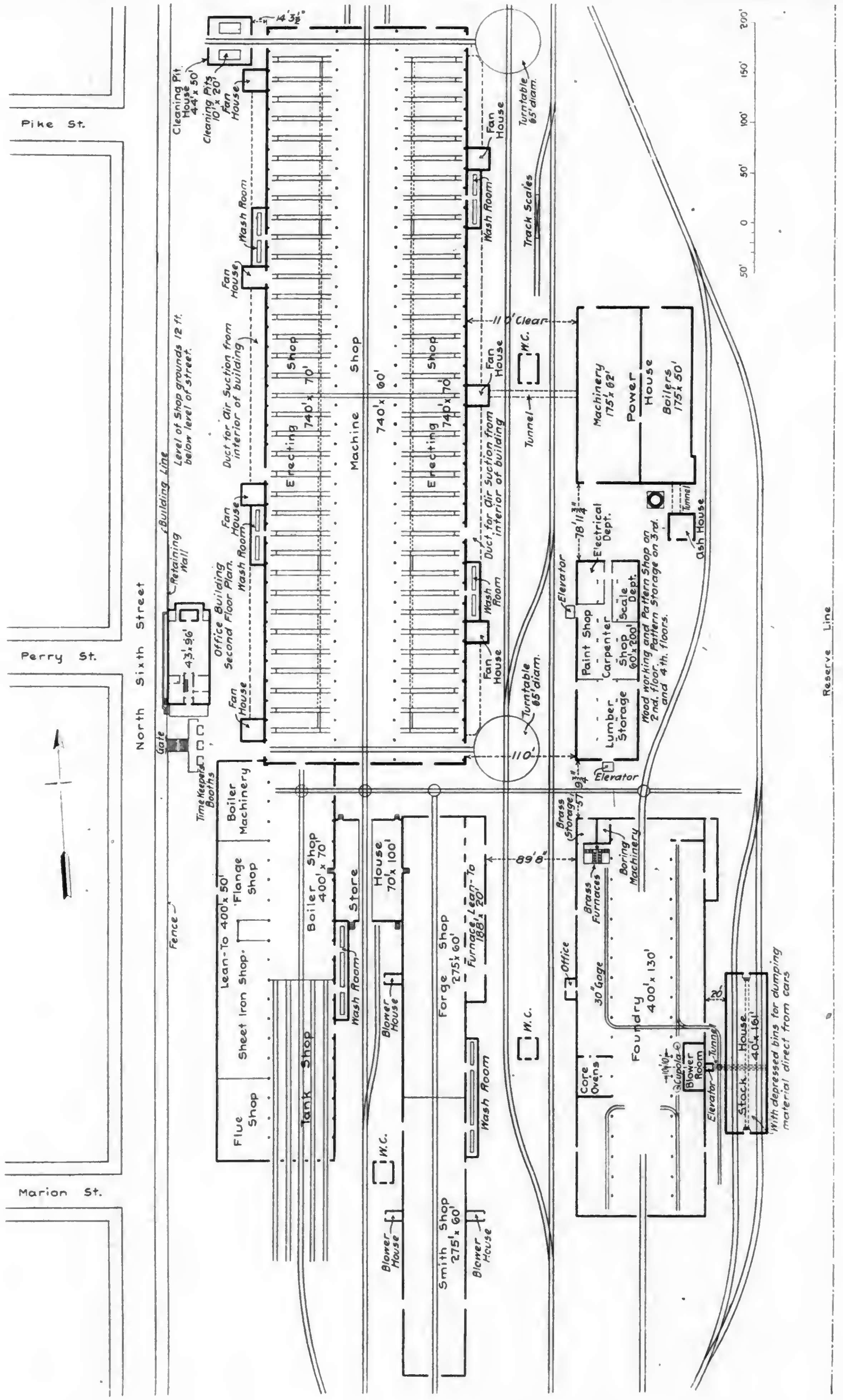
The power house location was important. In deciding upon its position the probable power consumption of the shops was carefully estimated, which revealed the fact that the center of the demand for power was close to the center of the locomotive shop. On account of the large quantity of power used in the locomotive building the power house was placed opposite its center. The cable and pipe tunnel leading from the power house enters the locomotive shop at its center and the crane, power and lighting mains are all fed at the middle of their length. This reduces the cost of feeders in this shop to one-fourth of that required by feeding at either end. At first it was intended to locate the power house at the south end of the shop yard, but this was abandoned for the reason stated. For distant transmission, as in the case of the yard lighting and the operation of the pumping plant at North Reading, 3,000 ft. away, where three motors are to be used for pumping purposes, the location of the power house did not matter so much as the transmission is by alternating current of sufficiently high voltage.

The main entrance for employees is through time-keepers' booths, with six gates, located at the south end of the office building at North Sixth street. Here the men are checked in and out. As the men enter the gates the time-keepers in the booths hand them numbered checks, which they retain while in the shop, returning them upon leaving. In this way the time of every man is taken from the length of time the check is out. The six gates easily accommodate 1,500 men, which is the number now employed at these works.

Locomotive Shop.—This building is the largest of its kind in this country. It is 750 ft. long by 200 ft. wide, with no divisions or partitions. The roof trusses of the erecting bays are 46 ft. 6 ins. from the floor and those of the machine shop are 33 ft. 5 ins. The crane service in this building is admirable, covering the entire floor area, including the machine shop, and it will be described in detail in a later issue.

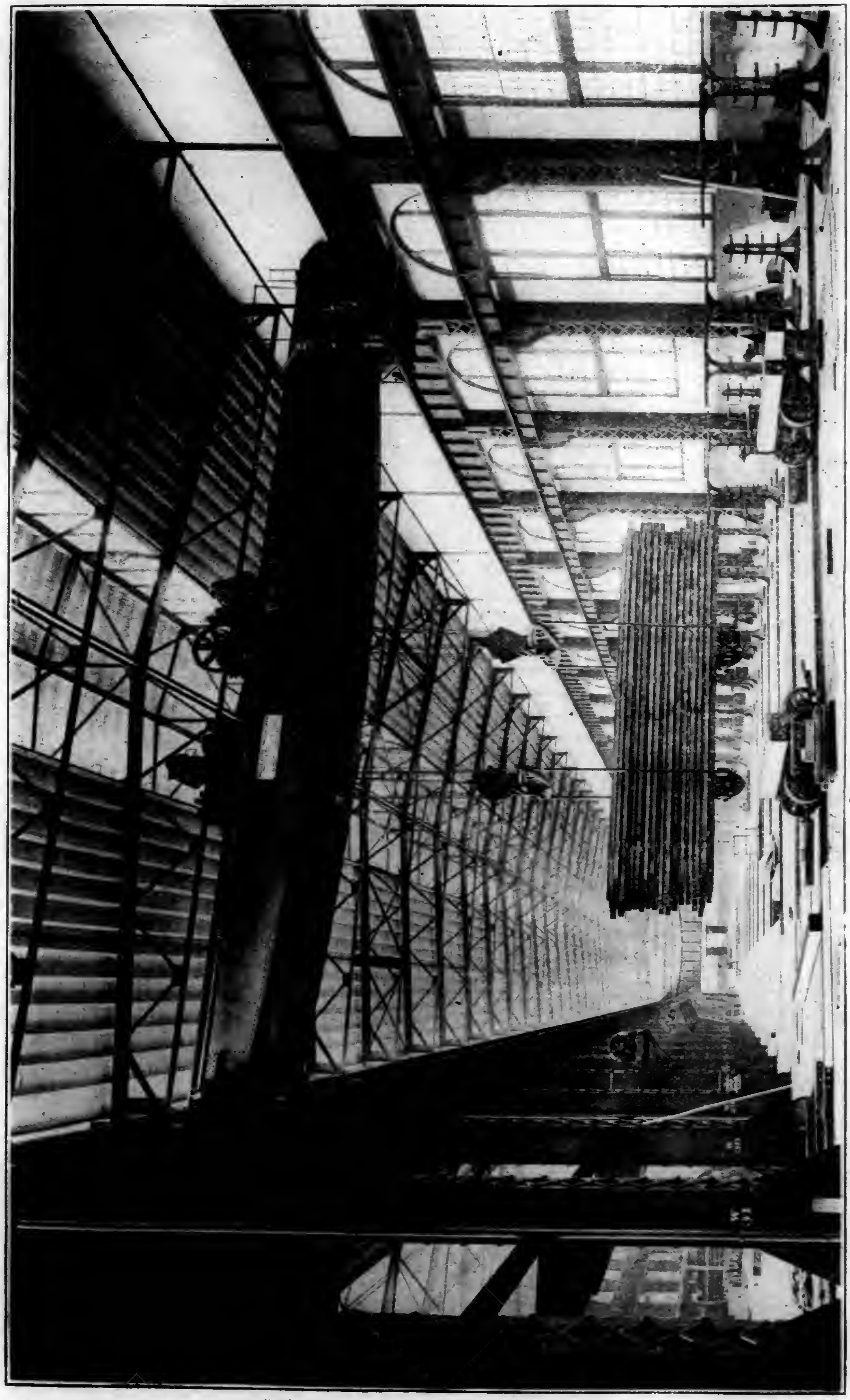
One of the large 120-ton cranes, with its test load of 150 tons of steel rails, is shown in the large interior view of one of the erecting-shop bays. Each erecting-shop bay has one of these 120-ton Niles cranes with two 60-ton trolleys and an auxiliary 6,000-lb. hoist. These are the most powerful cranes ever put into railroad shops. On lower rails each of these shops has a 35-ton crane, and the boiler shop has one of this size also. The west side, therefore, has three cranes. Two 10-ton cranes serve the machine shop over its entire length.

By placing the heating fans outside of the building in seven lean-to fan-houses, locating the fan-ducts underground and locating the wash-room and accessories also in lean-tos, renders every square foot of floor area of this enormous building available for locomotives or machinery. At the northwest corner of the building is the cleaning pit in a building by itself, which is reached by the through track



NEW LOCOMOTIVE SHOPS, AT READING, PA.—PHILADELPHIA & READING RAILWAY.

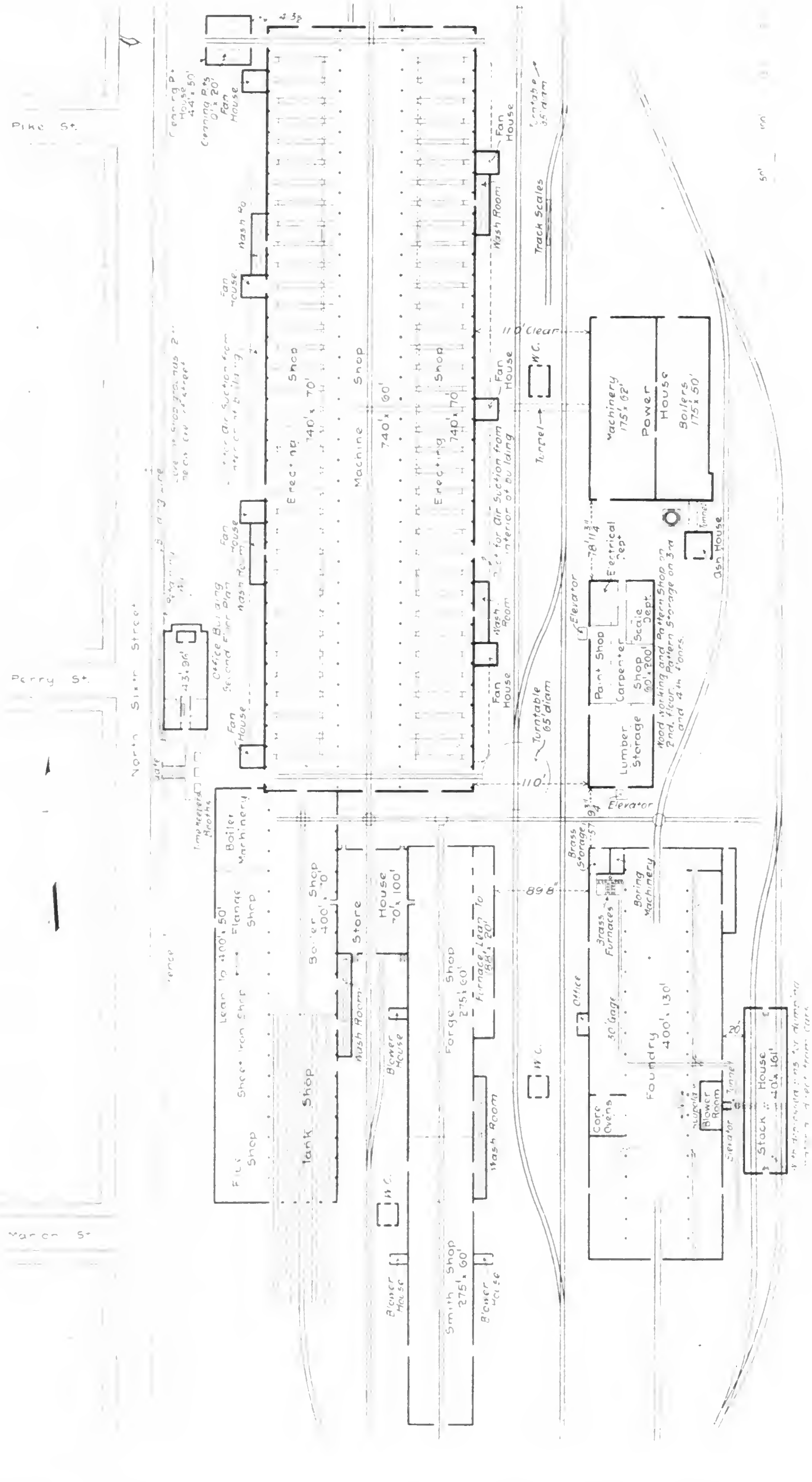
S. F. PRINCE, JR., *Superintendent Motive Power.* WILSON BROTHERS & Co., Philadelphia, *Architects.*



NEW LOCOMOTIVE SHOPS AT READING—PHILADELPHIA & READING RAILWAY

INTERIOR OF ONE OF THE ERECTING BAYS.

120-TON NILES ELECTRIC TRAVELING CRANE, WITH 150-TON TEST LOAD.



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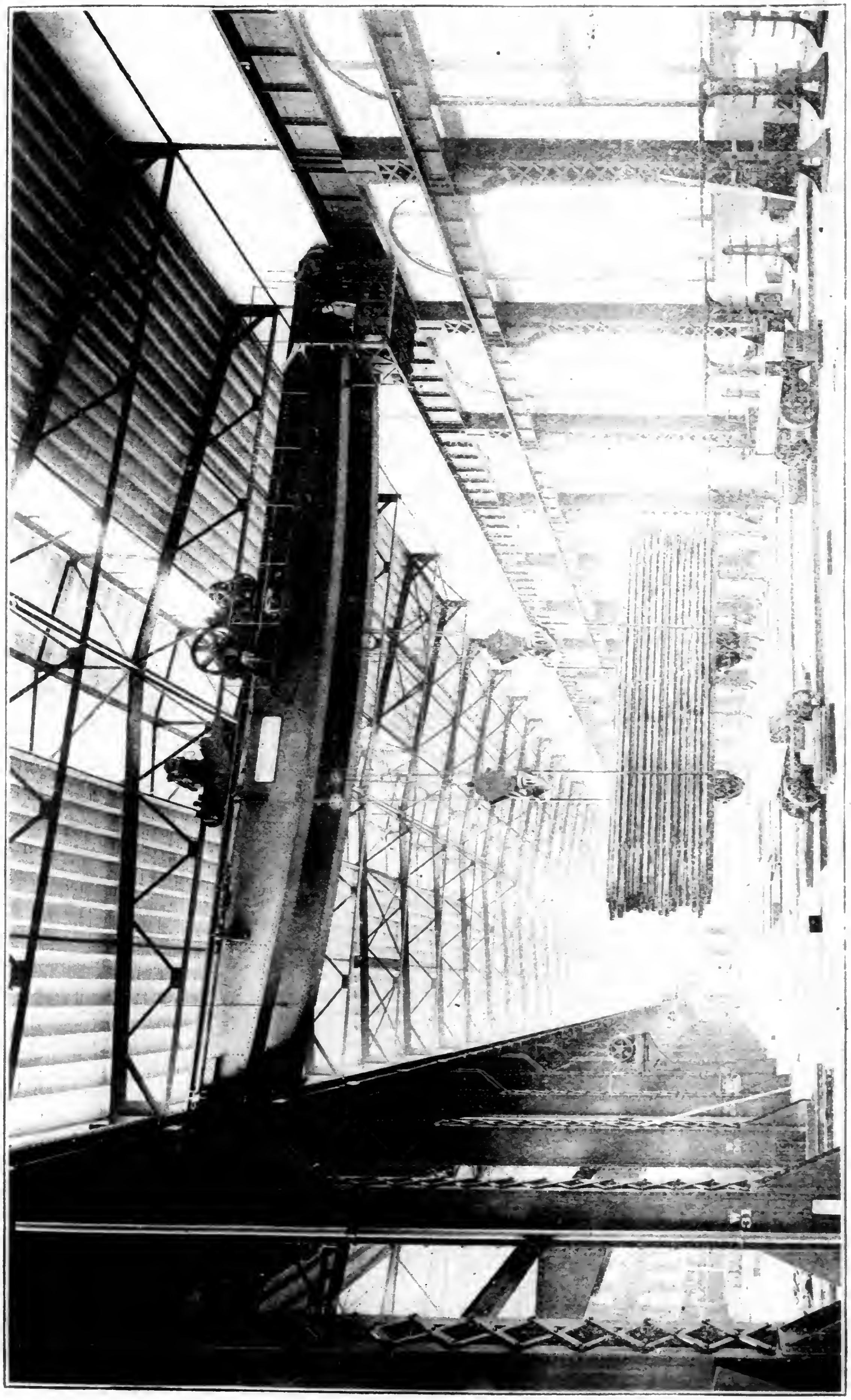
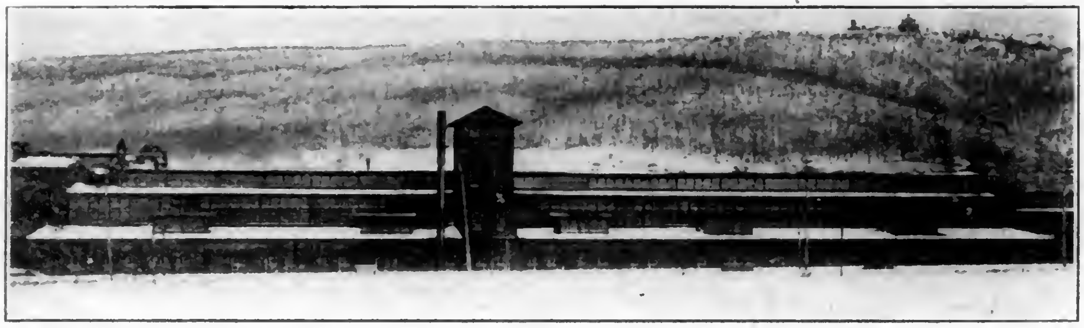


NEW LOCOMOTIVE SHOPS AT READING—PHILADELPHIA & READING RAILWAY.

INTERIOR OF ONE OF THE ERECTING BAYS.

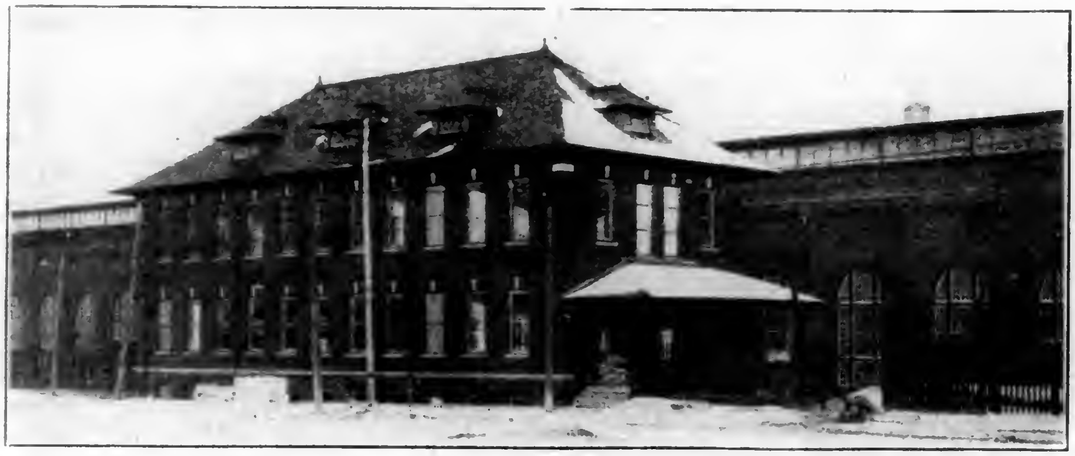
120 TON NILES ELECTRIC TRAVELING CRANE WITH 150 TON TEST LOAD.

NORTH END OF LOCOMOTIVE SHOP, WITH MACHINE SHOP IN CENTER AND CLEANING-PIT HOUSE AT RIGHT.



BOILER SHOP, FROM HIGH GROUND TO THE WEST. RIVETING TOWER AT THE CENTER. SHOWS THE LARGE AMOUNT OF GLASS IN ROOF.

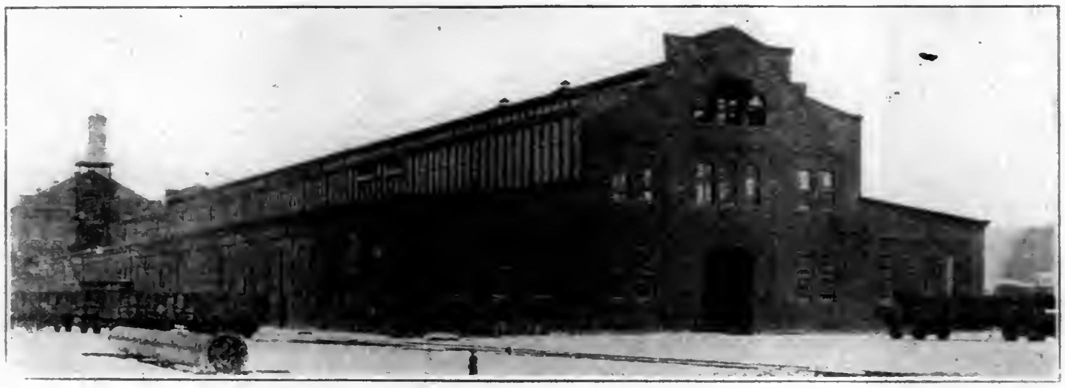
SOUTH END OF BOILER SHOP. FLUE DEPARTMENT LEAN-TO AT THE LEFT. ROLLING SHUTTER DOORS TO FIVE TANK REPAIR TRACKS. BLACKSMITH SHOP AT RIGHT. STOREHOUSE APPEARS AT THE REAR. ALSO SHOWS LAVATORIES AND FURNACE HOUSES AT THE RIGHT.



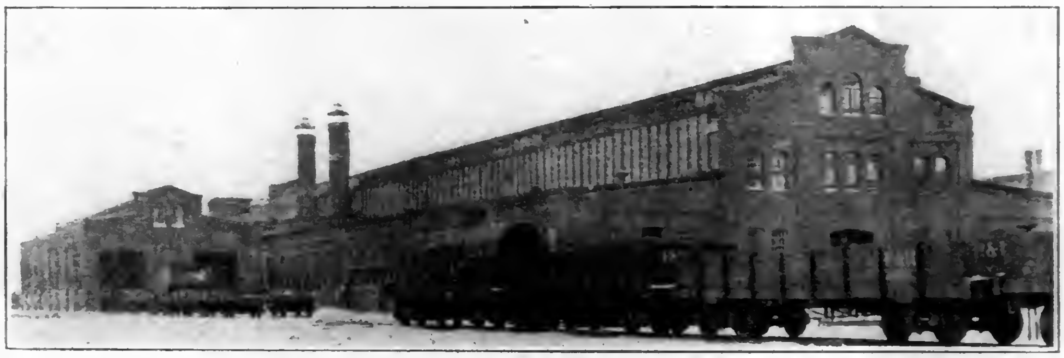
SIDE VIEW OF LOCOMOTIVE SHOP AND OFFICE BUILDING. MAIN ENTRANCE GATE AT THE RIGHT.

NEW LOCOMOTIVE SHOPS AT READING—PHILADELPHIA & READING RAILWAY.

SMITH AND FORGE SHOP BUILDING, FROM SOUTHWEST CORNER, SHOWING FURNACE LEAN-TOS AND WASHROOMS AT RIGHT.

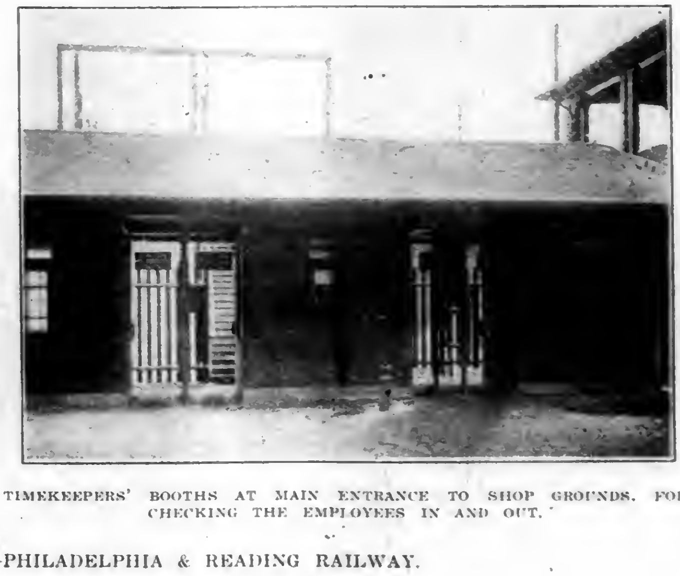


FOUNDRY FROM SOUTHWEST CORNER, SHOWING INSULATOR-RACKS AT GABLE WINDOW FOR OVERHEAD WIRE SYSTEM.



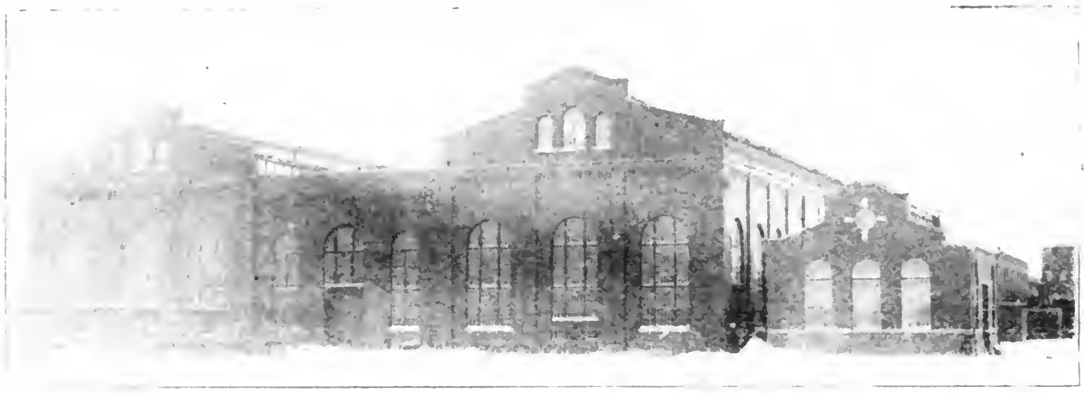
VIEW OF FOUNDRY FROM NORTHWEST CORNER, SHOWING CUPOLAS AND STOCKHOUSE AT LEFT.

CARPENTER-SHOP BUILDING, SHOWING OUTSIDE STEEL CONSTRUCTION FOR ELEVATOR SERVING THE PATTERN LOFTS.

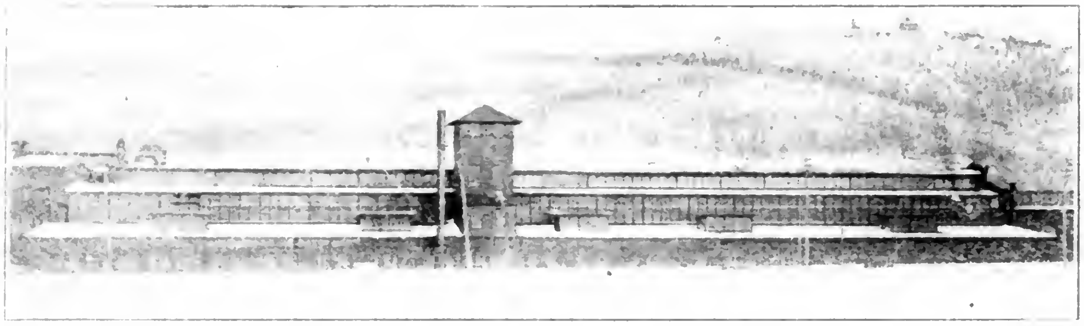


TIMEKEEPERS' BOOTHS AT MAIN ENTRANCE TO SHOP GROUNDS. FOR CHECKING THE EMPLOYEES IN AND OUT.

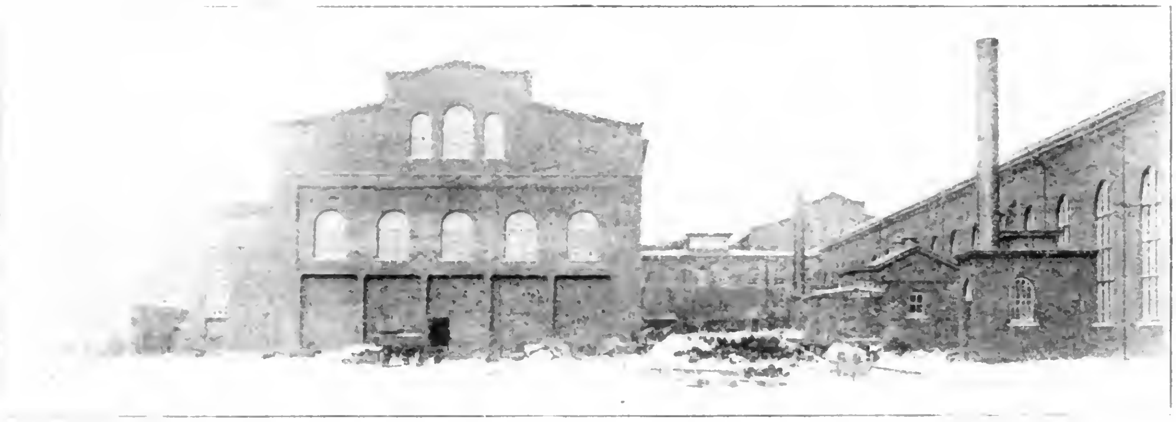
NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.



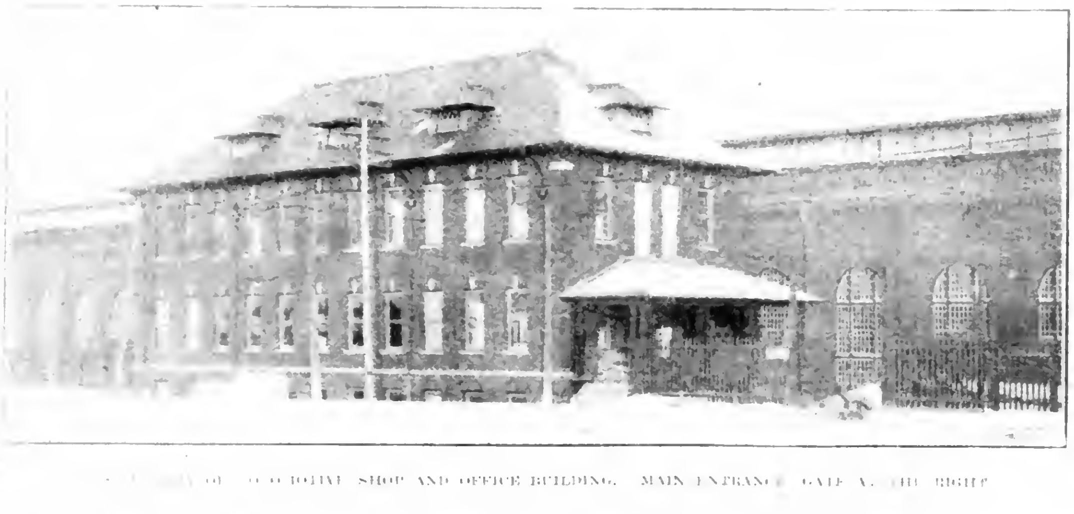
[illegible] LOCOMOTIVE SHOP, WITH MACHINE SHOP IN CENTER AND CLEANING PIT HOUSE AT RIGHT.



[illegible] FROM THE WEST [illegible] TOWER [illegible] THE CENTER. SHOWS THE LARGE AMOUNT OF GLASS IN ROOF.

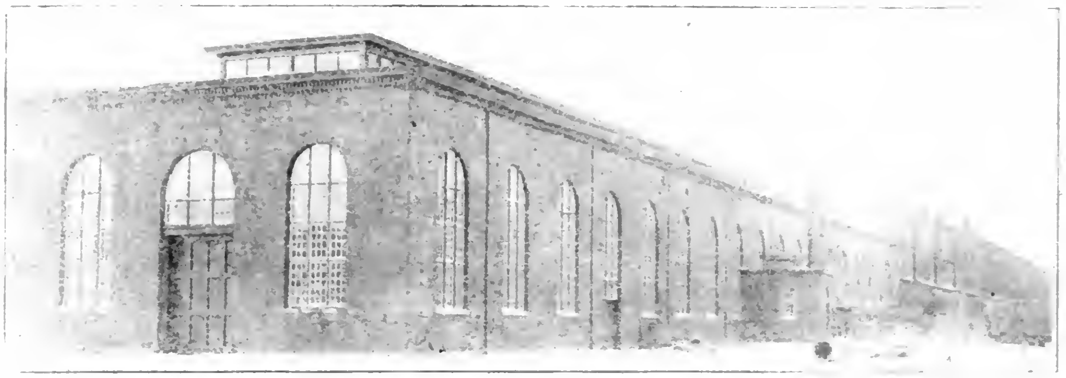


[illegible] LEAN-TO AT THE LEFT [illegible] SHUTTER DOORS TO FIVE TANK REPAIR TRACKS [illegible] APPEARS AT THE REAR. ALSO SHOWS LAVATORIES AND FURNACE HOUSES AT THE RIGHT.

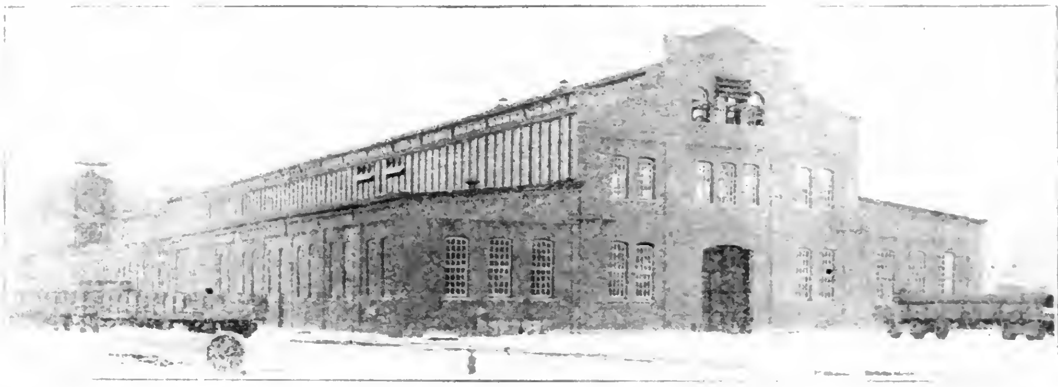


[illegible] OF LOCOMOTIVE SHOP AND OFFICE BUILDING. MAIN ENTRANCE GATE AT THE RIGHT.

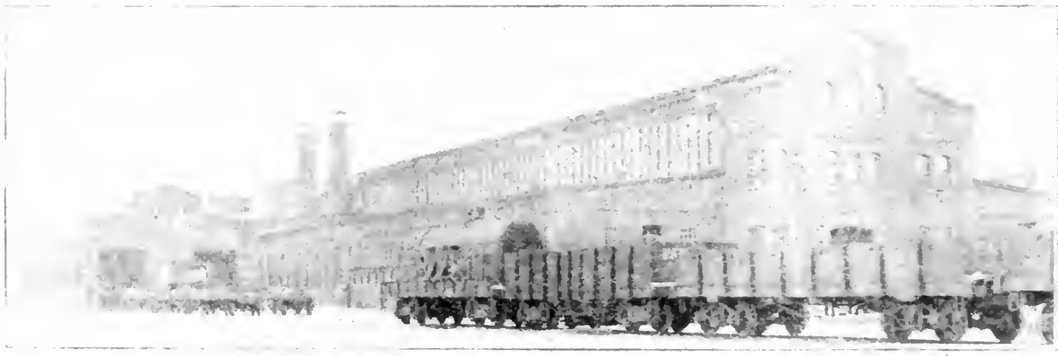
NEW LOCOMOTIVE SHOPS AT READING, PHILADELPHIA & READING RAILWAY.



SMITH AND FORGE SHOP BUILDING, FROM SOUTHWEST CORNER, SHOWING FURNACE [illegible] AND WASHROOMS AT RIGHT.



FOUNDRY FROM SOUTHWEST CORNER, SHOWING INSULATOR-RACKS AT GABLE WIN[illegible] OVERHEAD WIRE SYSTEM.



VIEW OF FOUNDRY FROM NORTHWEST CORNER, SHOWING CUPOLAS AN[illegible] AT LEFT.

CARPENTER SHOP BUILDING, SHOWING OUTSIDE STEEL CONSTRUCTION FOR ELEVATOR SERVING THE PATTERN LOFTS.

TIMEKEEPERS' BOOTHS [illegible] ENTRANCE TO SHOP GROUNDS, FOR CHECKING [illegible] EMPLOYEES IN AND OUT.

NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.

across the north end of the shop. The locomotive-shop building is lighted by large windows and large areas of glass in the monitors on the roofs. A good idea of the natural lighting is presented in the large photograph already referred to. The arrangement of the main bay of the boiler shop in line with the west bay of the erecting shop is admirable for the west-side erecting bay. Boilers from the east erecting-shop bay will be transferred to the west side of the shop upon trucks and carried to the boiler shop by one of the cranes. It will be noticed that three tracks will be available for such movements, one at each end and one in the middle of the locomotive shop. This idea of continuous crane service of the locomotive and boiler shop was first employed in the Concord shops of the Boston & Maine, illustrated in this journal in February, 1898. It will be noted that the arrangement of the two plants are very different, however, that of the Concord shops being with longitudinal tracks.

SOUTHWEST CORNER OF POWER-HOUSE, SHOWING STACK AND DUMPING ASH-TOWER AT RIGHT.

POWER-HOUSE FROM SOUTHEAST, SHOWING DUMPING CHUTES IN ASH-TOWER, AND COALING TRACK.

Proportions.—In studying the plans of these shops the following dimensions and proportions may be found interesting:

Floor Areas in Square Feet.

Erecting floors, 740 x 140	103,600
Machine shop, 740 x 60	44,400
Boiler shop, 400 x 120	48,000
Smith and forge, 568 x 60, 188 x 20	37,840
	233,840
Carpenter shop, 60 x 200 x 4	48,000
Power-house, 175 x 112	19,600
Foundry, 400 x 130	52,000
Storehouse, 100 x 70 x 2	14,000
Stockhouse, 161 x 40	6,440
Office building, 43 x 96 x 3	12,384
Cleaning pit, 44 x 50	2 200
	154,624
Locomotive shops proper	233,840
Accessory departments	154,624
Total floor area	388,464

Proportion of Area to Total Locomotive Shops Proper.

Erecting shop	103,600 sq. ft.	44%
Machine shop	44,400 sq. ft.	19%
Boiler shop	48,000 sq. ft.	21%
Smith and forge	37,840 sq. ft.	16%
	233,840 sq. ft.	100%

Relation to Erecting Floor.

Erecting floor	103,600 sq. ft.	100%
Machine shop	44,400 sq. ft.	43%
Boiler shop	48,000 sq. ft.	46%
Smith and forge	37,840 sq. ft.	36%

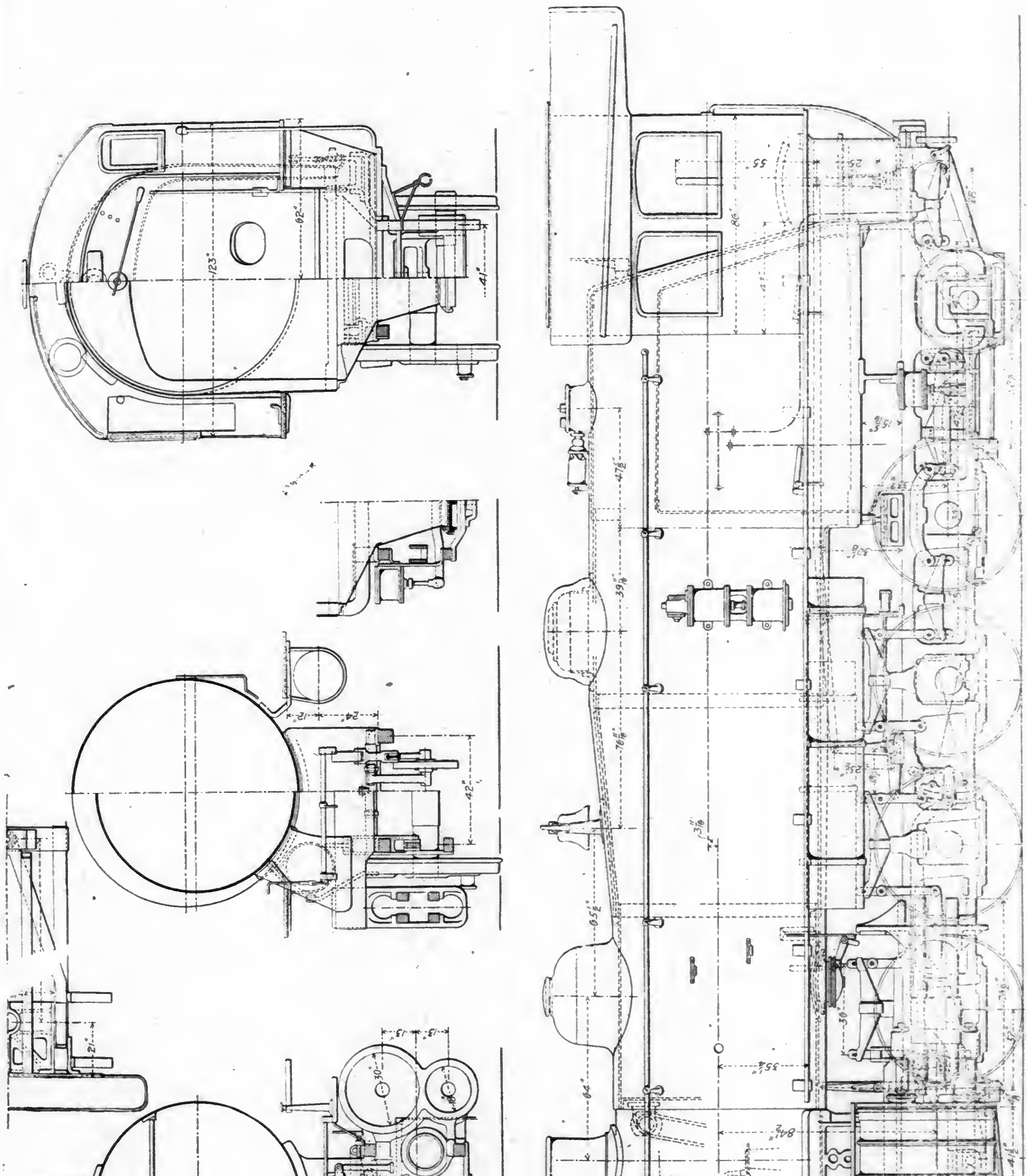
These proportions are interesting in comparison with the corresponding figures for the Collinwood shops of the Lake Shore & Michigan Southern Railway (American Engineer, October, 1902, page 304). These are summarized as follows in terms of the total area of locomotive shops proper:

	Collinwood.	Reading.
Erecting shop	22%	44%
Machine shop	33%	19%
Boiler shop	25%	21%
Blacksmith and forge	19%	16%

These figures will be misleading unless the descriptions of the two plants are carefully studied. With the erecting space considered as 100 per cent., the comparison is as follows:

	Collinwood.	Reading.
Erecting floor	100%	100%
Machine shop	147%	43%
Boiler shop	113%	46%
Smith and forge	84%	36%

In subsequent issues the construction of the buildings and the arrangement of their machinery and equipment will be presented in detail.



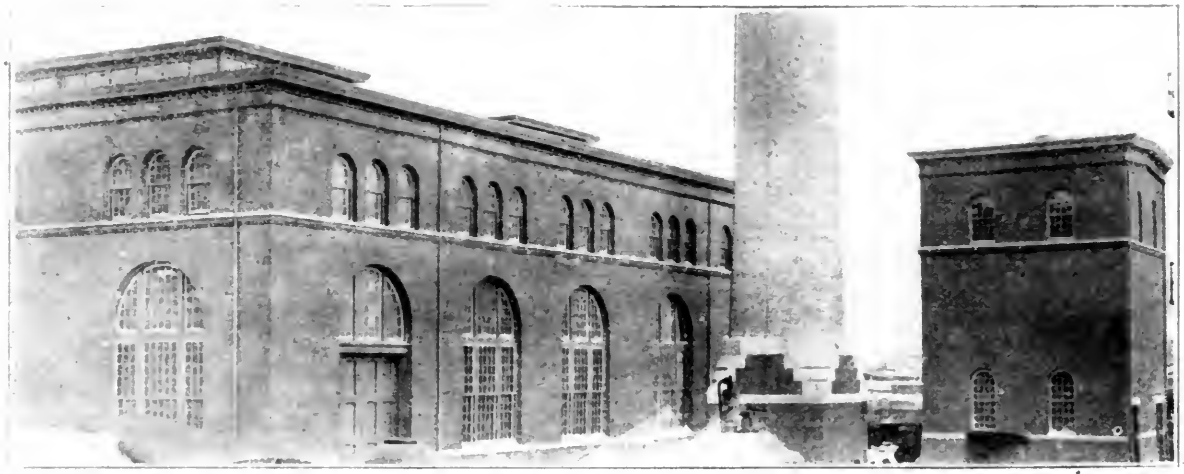
HEAVY COMPOUND FREIGHT LOCOMOTIVE.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

2—8—2 TYPE.

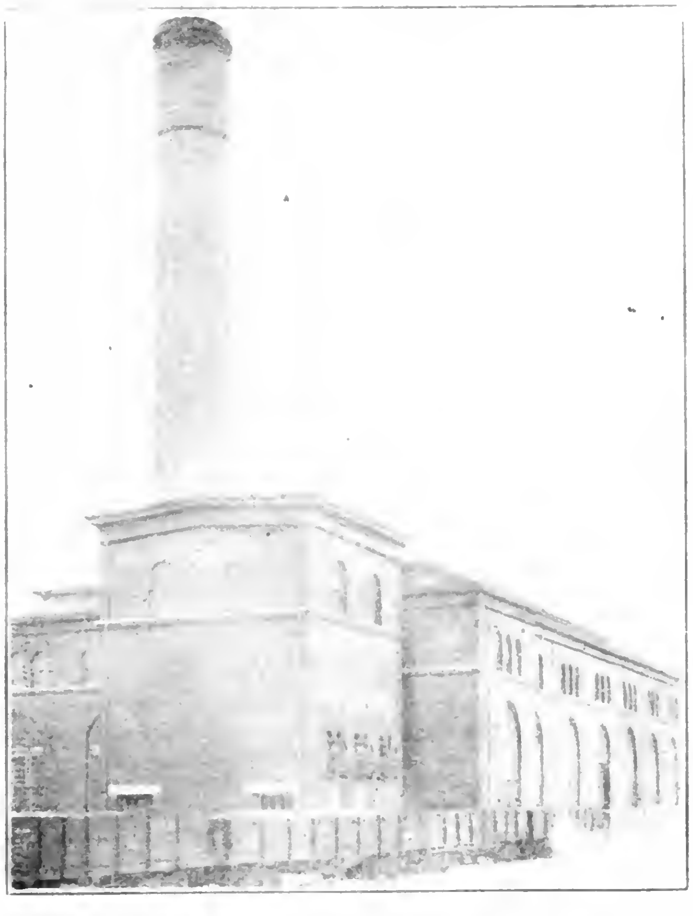
G. R. HENDERSON, *Superintendent of Motive Power.*

BALDWIN LOCOMOTIVE WORKS, *Builders.*

across the north end of the shop. The locomotive-shop building is lighted by large windows and large areas of glass in the monitors on the roofs. A good idea of the natural lighting is presented in the large photograph already referred to. The arrangement of the main bay of the boiler shop in line with the west bay of the erecting shop is admirable for the west-side erecting bay. Boilers from the east erecting-shop bay will be transferred to the west side of the shop upon trucks and carried to the boiler shop by one of the cranes. It will be noticed that three tracks will be available for such movements, one at each end and one in the middle of the locomotive shop. This idea of continuous crane service of the locomotive and boiler shop was first employed in the Concord shops of the Boston & Maine, illustrated in this journal in February, 1898. It will be noted that the arrangement of the two plants are very different, however, that of the Concord shops being with longitudinal tracks.



SOUTHWEST CORNER OF POWER HOUSE, SHOWING STACK AND DUMPING ASH TOWER AT RIGHT.



POWER HOUSE FROM [illegible], SHOWING DUMPING CHUTES IN ASH TOWER [illegible] COALING TRACK.

Proportions.—In studying the plans of these shops the following dimensions and proportions may be found interesting:

Floor Areas in Square Feet.

Erecting floors, 740 x 140	103,600
Machine shop, 740 x 60	44,400
Boiler shop, 400 x 120	48,000
Smith and forge, 568 x 60, 188 x 20	37,840
	233,840
Carpenter shop, 60 x 200 x 4	48,000
Power-house, 175 x 112	19,600
Foundry, 400 x 130	52,000
Storehouse, 100 x 70 x 2	14,000
Stockhouse, 161 x 40	6,440
Office building, 43 x 96 x 3	12,384
Cleaning pit, 44 x 50	2,200
	154,624
Locomotive shops proper	233,840
Accessory departments	154,624
Total floor area	388,464

Proportion of Area to Total Locomotive Shops Proper.

Erecting shop	103,600 sq. ft.	44%
Machine shop	44,400 sq. ft.	19%
Boiler shop	48,000 sq. ft.	21%
Smith and forge	37,840 sq. ft.	16%
	233,840 sq. ft.	100%

Relation to Erecting Floor.

Erecting floor	103,600 sq. ft.	100%
Machine shop	44,400 sq. ft.	43%
Boiler shop	48,000 sq. ft.	46%
Smith and forge	37,840 sq. ft.	36%

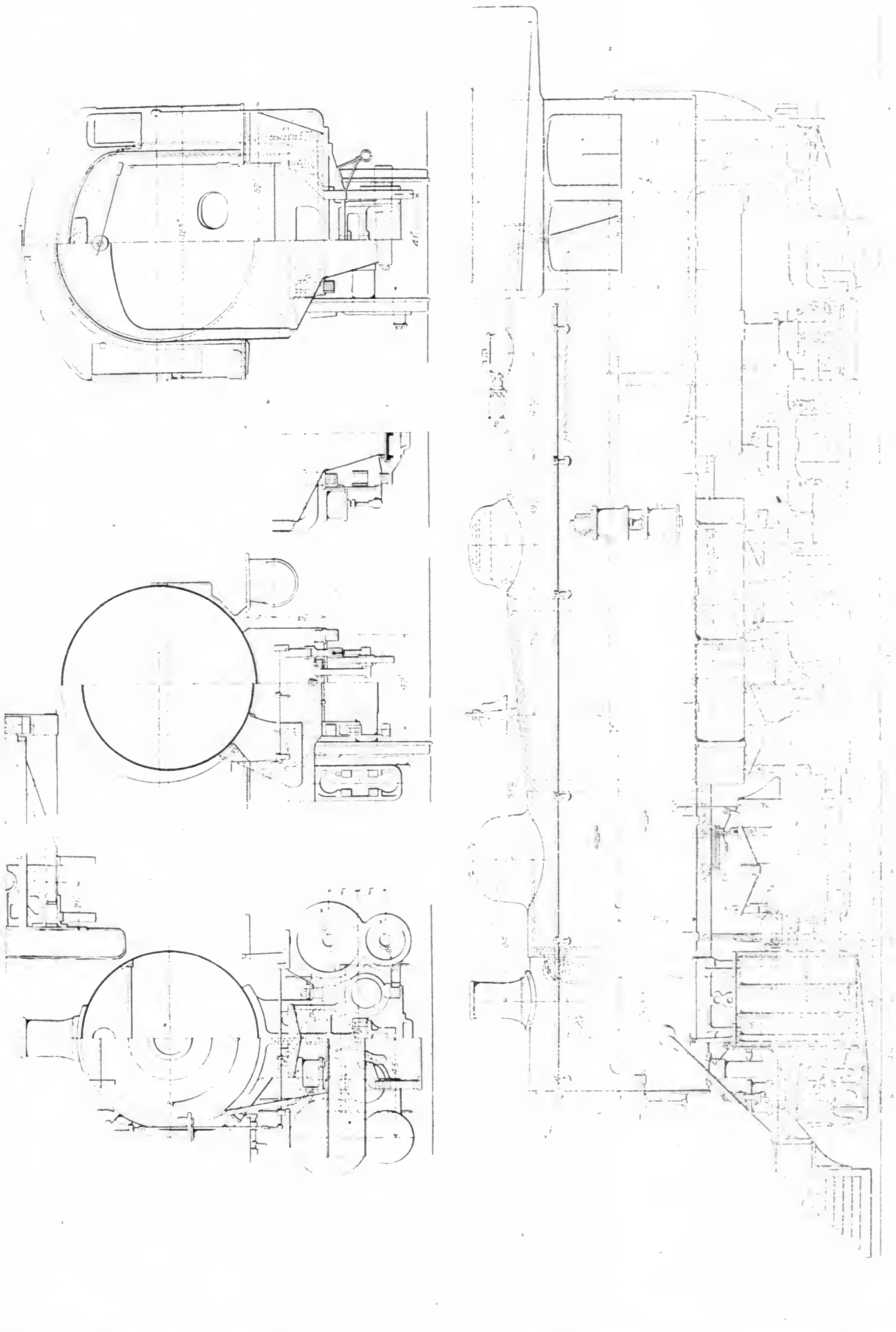
These proportions are interesting in comparison with the corresponding figures for the Collinwood shops of the Lake Shore & Michigan Southern Railway (American Engineer, October, 1902, page 301). These are summarized as follows in terms of the total area of locomotive shops proper:

	Collinwood	Reading
Erecting shop	22%	44%
Machine shop	33%	19%
Boiler shop	25%	21%
Blacksmith and forge	19%	16%

These figures will be misleading unless the descriptions of the two plants are carefully studied. With the erecting space considered as 100 per cent., the comparison is as follows:

	Collinwood	Reading
Erecting floor	100%	100%
Machine shop	117%	43%
Boiler shop	113%	46%
Smith and forge	81%	36%

In subsequent issues the construction of the buildings and the arrangement of their machinery and equipment will be presented in detail.



HEAVY COMPOUND FREIGHT LOCOMOTIVE—ATCHISON, TOPEKA & SANTA FE RAILWAY.

2—8—2 TYPE.

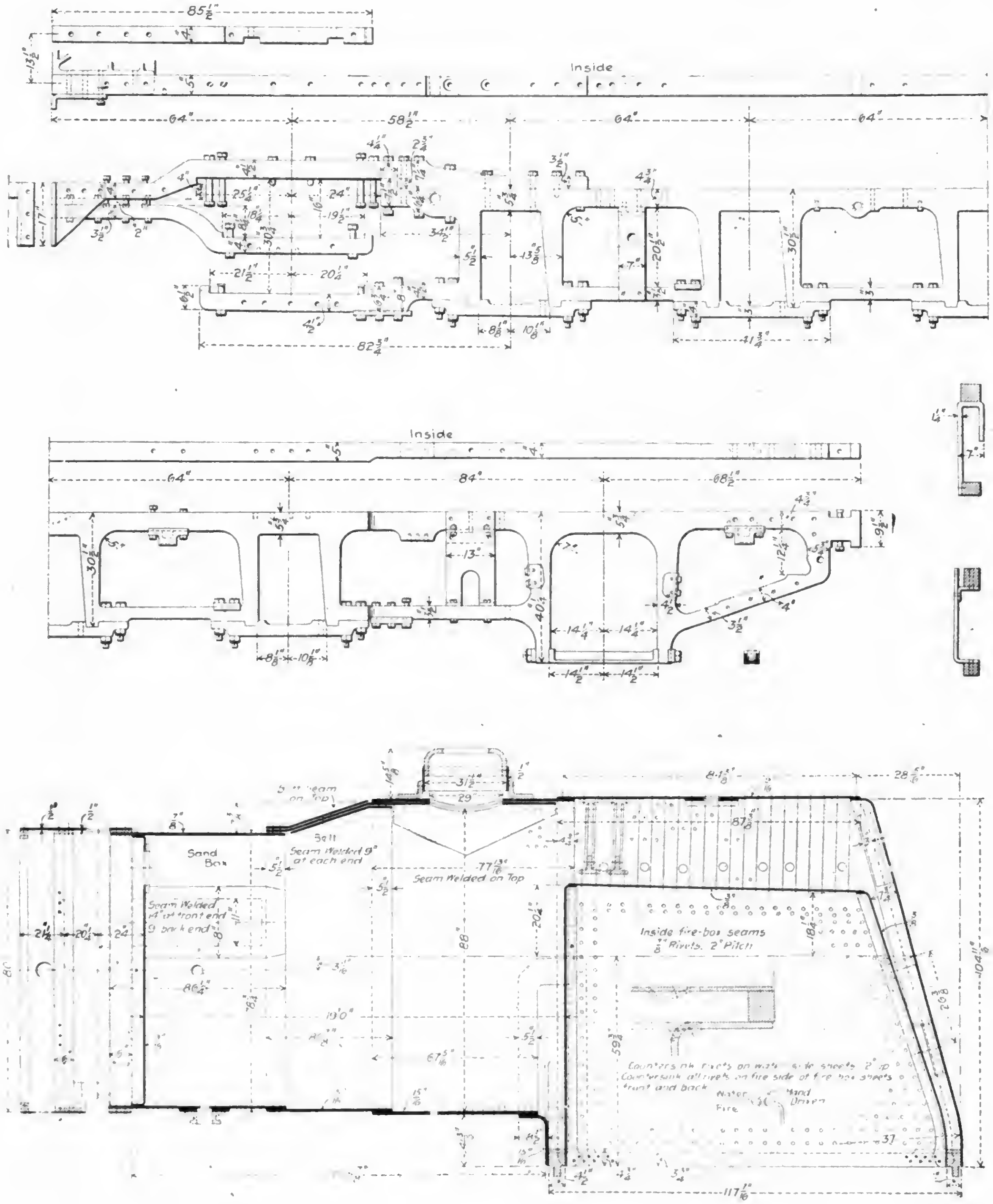
G. R. HENDERSON, *Superintendent of Motive Power*. BALDWIN LOCOMOTIVE WORKS, *Builders*.

HEAVY COMPOUND FREIGHT LOCOMOTIVES.

2—8—2 (MIKADO) TYPE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

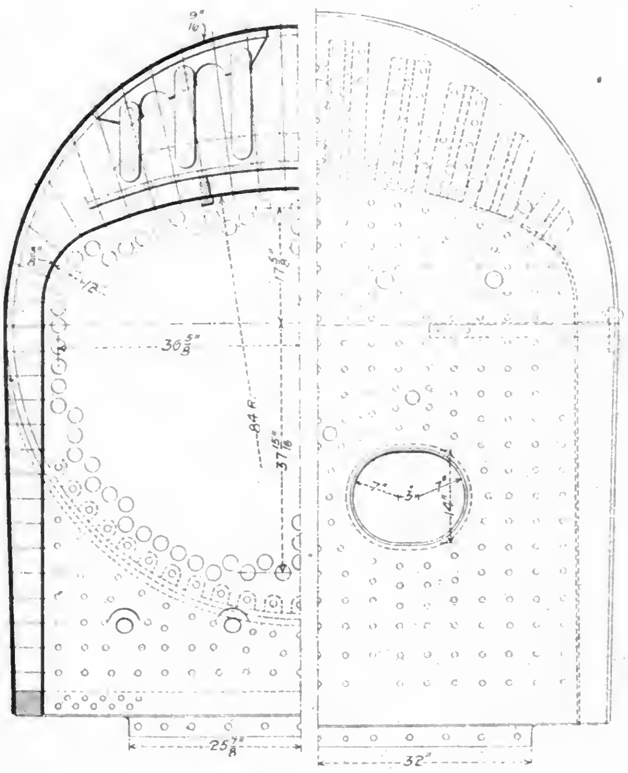
Fifteen of these heavy Vauclain compounds are now building at the Baldwin Locomotive Works. While considerably lighter than the design illustrated in the June number of this journal of last year, they are very heavy and powerful. A definite idea of their capacity is obtained from the tractive power (55,600 lbs.) and the heating surface (5,366 sq. ft.). In starting, using live steam in the low-pressure cylinder they are equivalent to single-expansion locomotives with 24-in cylinders. When running as compounds they are equivalent to single-expansion engines having 22.8-in. cylinders. The total weight is 260,000 lbs. and the weight on drivers (estimated) 200,000 lbs. In the matter of heating surface these engines have but 24 sq. ft. less than the largest area ever given to a locomotive, the 2—10—0 type of this road having 5,390 sq. ft. The boiler is practically the same as that illustrated in our June issue, both engines having 19-ft. tubes $2\frac{1}{4}$ ins. in diameter. The boiler pressure is 225 lbs. A photograph will be presented in a later issue and we hope to



BOILER AND FRAMES, HEAVY COMPOUND FREIGHT LOCOMOTIVE.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

give an account of the work which these engines are doing. For convenience in comparison with other heavy engines the following ratios are presented:

$\frac{\text{Heating surface}}{\text{Volume of h. p. cylinders}}$	578
$\frac{\text{Tractive weight}}{\text{Heating surface}}$	37.3
$\frac{\text{Tractive weight}}{\text{Tractive effort (compound)}}$	3.59
$\frac{\text{Tractive effort}}{\text{Heating surface}}$	10.36
$\frac{\text{Heating surface}}{\text{Grate area}}$	91.7
$\frac{\text{Tractive effort} \times \text{diameter of drivers}}{\text{Heating surface}}$	590



THE FIREBOX.

These engines are equipped with the Player traction increaser, applied to the leading and trailing trucks, as indicated in the side-elevation drawing. This device was described on page 373 of our December number, 1901. The trailing truck is Mr. Kenneth Rushton's design (American Engineer, 1902, page 235). The leading truck has "three-point" hangers and spiral springs. The frames are 5 ins. wide and 5¾ ins. deep over the driving boxes. Like the 2—10—0 type already referred to, these engines have 11 x 12-in. main driving journals, the other driving journals being 10 x 12 ins.

Atchison, Topeka & Santa Fe Railway.
2—8—2 (Mikado) Type.
Freight Locomotives.

Road number	900
Gauge	4 ft. 8½ ins.
Cylinder	18 and 30 x 32 ins.
Valve	Balanced piston
Boiler—Type	Wagon top
Diameter	78¾ ins.
Thickness of sheets	⅞ and 15-16 ins.
Working pressure	225 lbs.
Fuel	Coal
Staying	Radial
Height of center above rails	9 ft. 6½ ins.
Firebox—Material	Steel
Length	108 ins.
Width	78 ins.
Depth	Front, 80 ins.; back, 78 ins.
Thickness of sheets	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, 9-16 in.
Water space	Front, 4½ ins.; sides, 4 ins.; back, 4 ins.
Tubes—Material	Iron
Wire gauge	No. 11
Number	463
Diameter	2¼ ins.
Length	19 ft.
Heating surface—Firebox	210.3 sq. ft.
Tubes	5,155.8 sq. ft.
Total	5,366.1 sq. ft.
Grate area	58.5 sq. ft.
Driving wheels—Diameter outside	57 ins.
Diameter of center	50 ins.
Journals	Main, 11 x 12 ins.; others, 10 x 12 ins.
Engine truck wheels (front), diameter	29¼ ins.
Journals	6½ x 10½ ins.
Trailing wheels, diameter	40 ins.
Journals	76 x 12 ins.
Wheel base, driving	16 ft.
Rigid	16 ft.
Total engine	3 ft. 6½ ins.
Total engine and tender	62 ft.
Weight on driving wheels (est.)	200,000 lbs.
Total engine (est.)	260,000 lbs.
Total engine and tender (est.)	400,000 lbs
Tank, capacity	7,000 gals. and 12 tons.
Tender	Number of wheels, 8; diameter, 34¼ ins.
Journals	5½ x 10 ins.

COST OF OPERATING TURNTABLES BY POWER.

A comparative statement of costs of various methods of operating turntables by power, prepared for the Association of Railway Superintendents of Bridges and Buildings by Mr. F. E. Schall, bridge engineer of the Lehigh Valley Railroad, presents interesting figures. He states that equipments for driving turntables by gasoline engines cost about $1,100 and by electric motor (General Electric Company) about $1,150, and that the economy depends upon the number of engines turned, as the following record shows:

[Note.—These figures do not include interest or depreciation, which would amount to about 45 cents per day.]

64-Ft. Turn-Table at Coxton, Pa., 5 H. P. Gasoline Engine, Installed July, 1901.

Average number of engines turned per day of 24 hours in a period of one year, 174.
Average cost per engine turned in a period of one year, 2 21-100 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.78.

75-Ft. Diameter Turn-Table at Lehighton, Pa., Operated by 5 H. P. Gasoline Engine, Installed February 12, 1902.

Average number of engines turned per day of 24 hours, 121.
Average cost per engine turned, 2 9-10 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.41.

75-Ft. Diameter Turn-Table at South Easton, Pa., Operated by 5 H. P. Gasoline Engine, Installed March 14, 1902.

Average number of engines turned per day of 24 hours, 188.
Average cost per engine turned, 1 97-100 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.74.

75-Ft. Diameter Turn-Table at Wilkesbarre, Pa., Operated by 5 H. P. Gasoline Engine, Installed March 18, 1902.

Average number of engines turned per day of 24 hours, 46.
Average cost per engine turned, 6 5-10 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $2.91.

75-Ft. Diameter Turn-Table at East Buffalo, N. Y., Operated by 5 H. P. Gasoline Engine, Installed April 1, 1902.

Average number of engines turned per day of 24 hours, 103.
Average cost per engine turned, 3 37-100 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.41.

64-Ft. Turn-Table at Sayre, Pa., Operated by 20 H. P. Electric Motor, Installed June 1, 1902.

Average number of engines turned per day of 24 hours, 109.
Average cost per engine turned, 3 7-10 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $4.01.

Mr. Willard A. Smith, for many years publisher of the *Railway and Engineering Review*, has bought the *Age of Steel* and consolidated it with his other recent purchase, *Iron and Steel*. They will be published under the name of *The Iron and Machinery World*, with Mr. Smith as president and Mr. Bruce v. Crandall (who is associated with him) as secretary and treasurer. Under the management of these gentlemen the new publication is sure to build upon the records of the merging journals and reach a higher plane of success than either has attained alone.

THIRTY-TON BOX CAR WITH STEEL UNDERFRAME.

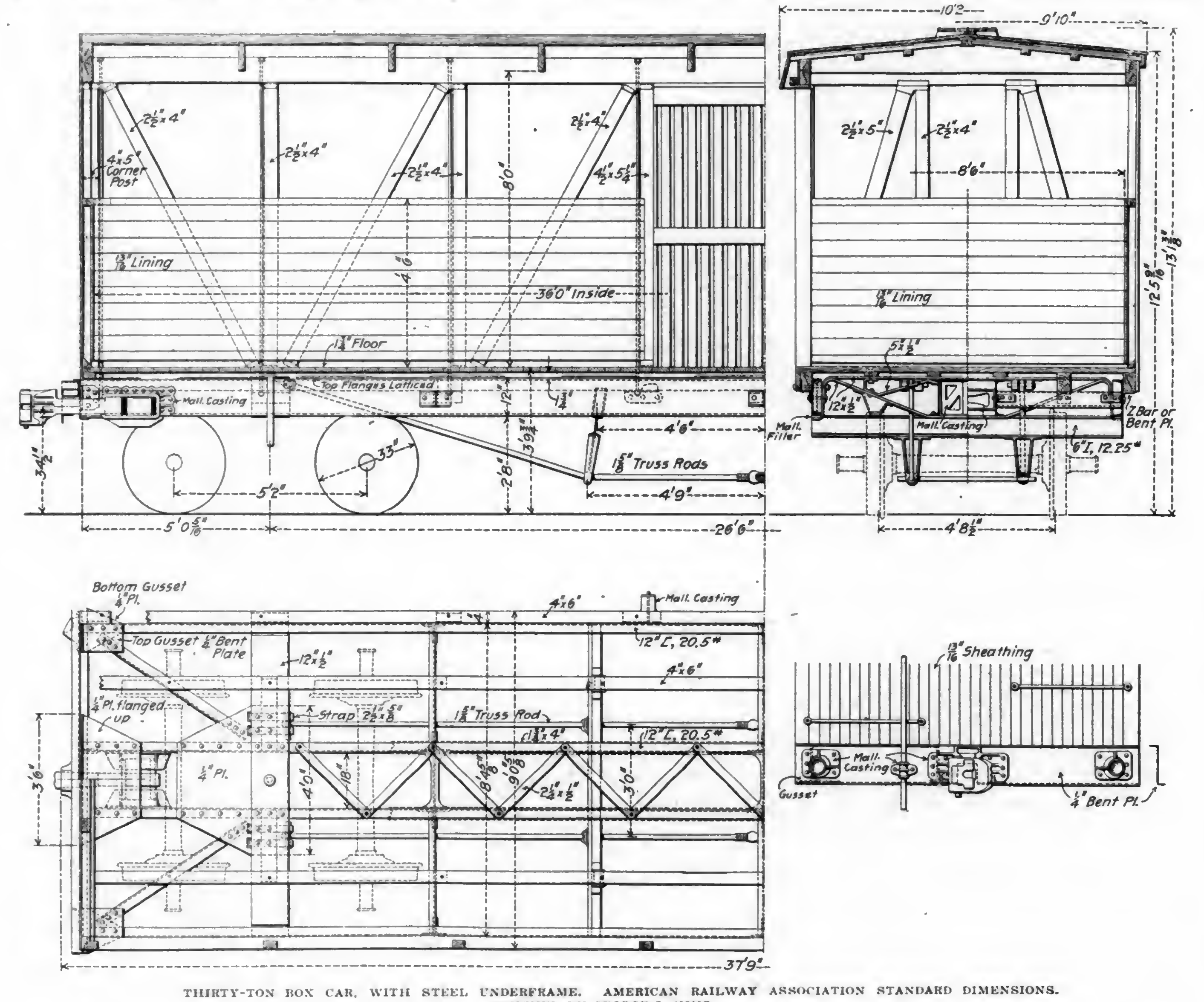
AMERICAN RAILWAY ASSOCIATION DIMENSIONS.

DESIGNED BY GEORGE I. KING.

This car was designed at the Middletown Car Works by Mr. George I. King in order to meet the demand for a structural underframe of ample strength but of such simple type that it may not only be built new in any ordinary railroad shop, but that it may be repaired with equal facility.

The four longitudinal sills are 12-in. channels, the center sills being trussed with $1\frac{5}{8}$-in. rods between the bolsters. stresses and the severe buffing stresses it was considered desirable to neglect a small possible saving in weight in favor of strength. The suggestion of trussing a steel underframe seems a little out of the ordinary at this time. There is no doubt, however, that this is a cheaper and lighter construction than one of equal strength made of rolled sections without the trussing, and with larger sills it would be difficult to secure the standard inside height. With this construction the height over the trucks is practically the same as it would be with pressed steel sills of the fish-bellied form.

Attention is directed to the gussets at the ends of the sills, which are flanged up to form shoulders for the subsills, to secure the end frame from being pushed out by the load.



THIRTY-TON BOX CAR, WITH STEEL UNDERFRAME. AMERICAN RAILWAY ASSOCIATION STANDARD DIMENSIONS. DESIGNED BY GEORGE I. KING.

The body bolsters are of 12 x ½-in. plates with 5 x ½-in. braces for the side bearings. Unique attachments of the body bolsters to the center sills and the truss rods to the body bolsters are shown. Two truss rods are used and they are located near the center sills, where they will not interfere with the curving of the trucks or cause any inconvenience with the side clearances of the car.

The truss rods were used because in the opinion of the designer the stresses in the center sills would be unduly great in a combination of severe buffing shocks or locomotive jerks with the direct stresses arising from the load in the car. It was considered wise to support the sills with these rods. For nearly vertical stresses channels lighter than 12 ins. could have been used, but for the combination

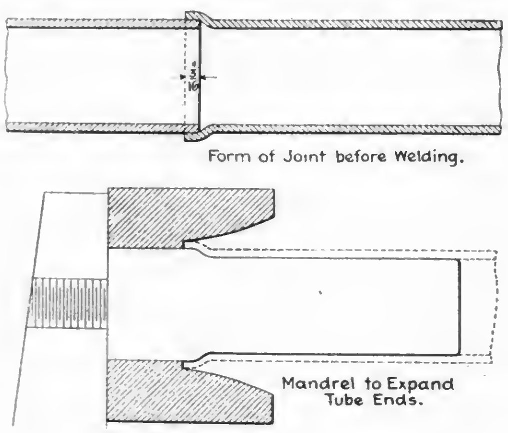
The end sill is a ¼-in. plate bent into Z-bar form, and is not secured in any way to the underframe except by means of the sill connection angles and the bottom corner gussets. It may therefore be easily removed for repairs without taking down the wooden structure. Though not shown in the drawing, the car will be constructed with a small space of perhaps ½ in. between the inside face of the end sill and the outside face of the end sheathing to allow rainwater to drip through to the trucks. Because of the compressive stress in the center sills, due to the tension in the truss rods, the center sills are latticed together on top. The drawing also shows side sill brackets made of Z bars to support the side nailing strips. One of these is placed under each post and the brackets take the nuts for the side-frame truss rods.

This form of bracket secures the nailing strips from side motion independent of the bolt connections. In the plan view the corner bracing and the plates over the center sills at the bolsters are worthy of special attention.

The designer sought to produce a structural underframe which with slight modifications would be applicable to flat, gondola, stock and box cars. It is an interesting construction and it is hoped that our readers will criticise it freely.

NOVO STEEL.

In the new era of improvements in shop methods the central and essentially vital elements are new tool steels and electric driving of machine tools. These go hand in hand, and it may be said that improved steels make motor driving necessary and that together these factors of the present situation will revolutionize not only shops methods but design, construction and speeds of driving of machine tools. As in the case of the projectile and armor plate, the projectile in this case—that is, the steel—is at present far ahead of the armor plate, represented by the machine. The new steels make new machines chatter with the heavy cuts which are now made possible. The machines must be made stronger and more rigid. The rules of the past few years in regard to motor capacity required for various machines, fail, and the motors are stalled by these cuts. The motors used must be more powerful than required by the rules which were sufficient only a year or so ago. The recently developed methods of hardening steel make it necessary to begin anew in these three important directions: To increase cutting speeds, provide geater strength and rigidity in machines and supply greater power to drive them.



SKETCH OF THE MANDREL DEVICE.

Blue chips are now found at the large machines in every shop pretending to be at all up to date, and in a tour of many shops recently made by a representative of this journal, "Novo" steel (Hermann Boker & Co., 101 Duane street, New York) was frequently found and as frequently praised by those who are using it. The remarks in the first paragraph on page 378 of our December number referred to this steel, and attempts will be made to secure more reliable data with regard to it. That paragraph has brought a large amount of correspondence indicating the vital interest which is taken in the subject. Additional reports of this steel indicate the possibility of speeds of 91 ft. per minute in boring Midvale tires with ⅛-in. cuts and ⅛-in. feeds. Axles are reported to have been turned at a rate of 45 ft. per minute with ⅜-in. cuts and ⅛-in. feeds. The most remarkable fact about this steel is that it may be annealed so that it machines and handles in the shop as readily as soft annealed tool steel.

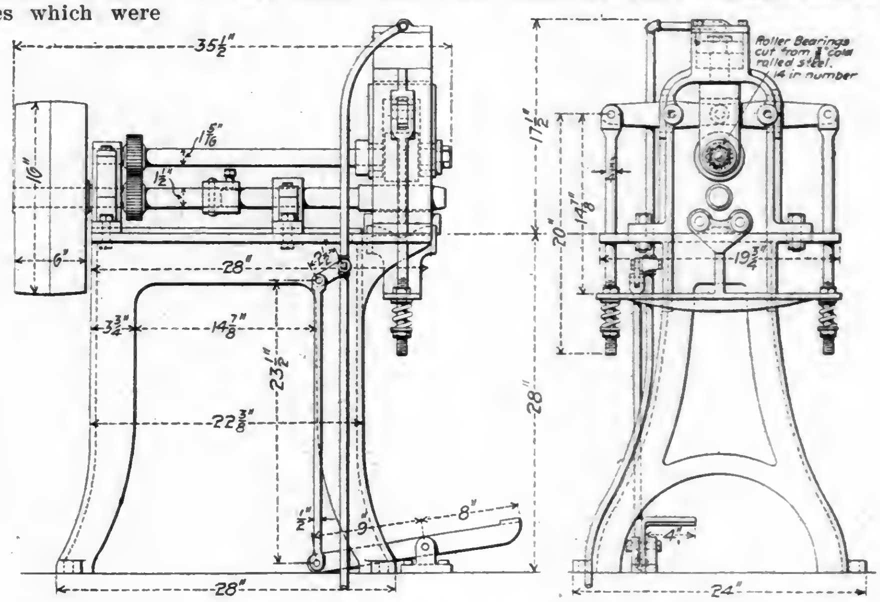
Further reports are at hand of 1 1-32-in. Novo steel drills running at 128 revolutions per minute and drilling 596 holes ⅝ in. deep in hard steel castings, without regrinding. Numerous other records are available and these will receive attention in these columns.

In presenting his paper upon the requirements of machine tool operation, recently read before the New York Electrical Society, Mr. Charles Day, of the engineering firm of Dodge & Day, placed Novo steel as equal if not superior to the well-known Taylor White steel.

PNEUMATIC FLUE WELDING MACHINE.

This interesting machine was developed and patented by Mr. H. A. Fergusson, assistant superintendent of motive power of the Chicago Great Western, and is in use at the Oelwein shops of that road, where it is attracting a great deal of attention because of its remarkable work.

The rotating spindle and the large roller are belt-driven, the mechanism being clearly shown in the engraving. When the tube with the safe end upon it is in position for welding, the foot lever is pressed and the upper roller, which is on a roller bearing, is forced downward with a pressure of about 1,200 lbs., by means of the air cylinder; the levers, acting through the spiral springs, raise the lower and longer rollers up against the under side of the tube at the same time. This makes so perfect a weld that the joint cannot be found when cool. A weld is completed in four or five seconds. Instead of scarfing the safe ends, they are simply cut off square, and the tubes heated and driven into a die over a mandrel which enlarges the ends enough to pass over the safe ends with a parallel fit 3-16 in. long. A very short fit is sufficient. The writer was shown a piece of tube 4 ft. long made up with 11 welds and none were evident upon the surface.



FERGUSSON'S PNEUMATIC FLUE WELDING MACHINE.

To return the upper roller to its normal position after the air is exhausted, a spring is placed under the piston in the cylinder. The spiral springs shown in the end view are to adjust the pressure of the bottom rolls. This machine makes a cylindrical weld. Since March 25, 1902, the tubes of 53 engines and enough more to make a total of 25,000 tubes have been welded on this machine with a saving in tube material sufficient to retube one entire engine. The welds from this machine do not leak and they are not even tested before being placed in the boilers.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

Owing to the unusual demand for space in this number the record of the American Engineer Tests must be interrupted for one issue. We can now state that the results are satisfactory and tnat very valuable relationships of the front end factors have been established.

There is one advantage that results from the use of the electric motor for driving machine tools which is almost entirely overlooked, namely the facility with which it may be ascertained whether a particular machine thus driven is operating at its highest efficiency. This may, with suitable current measuring instruments, be accomplished by comparing the power consumed by the motor in driving it with the power required for driving another similar machine. In the case of a number of macnine tools individually driven by motors, if it is suspected that one machine is using too much power, a brake test of the motors or an exchange of motors will quickly show the truth of the matter, and may suggest an easing up of bearings in different places or other changes to get rid of waste of power.

In connection with the reported retirement of Mr. F. W. Webb from the position of chief mechanical engineer of the London & North Western Railway it is stated that his salary is $35,000 per year, while that of his predecessor, Mr. Ramsbottom, many years ago, was $25,000 per year. In view of the fact that the United States, rather than England, is noted as a country of high salaries, this fact is noteworthy and important. It seems appropriate to ask why our motive power superintendents receive such miserably small compensation for the work which they do. Can it be possible that we do not have men in this country worth $35,000 a year, and that it does not pay to give such a salary to a $5,000 or a $6,000 man? If there is a position connected with any mechanical pursuit which calls for greater ability, knowledge, experience and business capacity than that required to properly manage the motive power interests of a large American railroad, we do not know where to find it. It is a fact that many of the best motive power officers have been attracted to other lines of industry and it is now exceedingly difficult to find men who can do what railroad owners want to have done. These men are sought by manufacturing concerns because their peculiar qualifications are required in the management of large industrial enterprises. It is practically impossible for men in other pursuits to apply their experience to railroads; consequently the railroads are losing and not gaining good men. They must necessarily train their own officers and if they expect to properly meet the problems of the future they must attend to the salaries at once, but this is not all. The time has arrived when a man who is merely a good mechanic, organizer and executive cannot fill the bill. He must be also a good business man. To attract and keep such men in the service, the gates to the higher operating positions must be thrown wide open to furnish an outlet for their talents. When both of these things are done, and not until then, can the ranks of motive power officials be properly recruited.

ELECTRICAL EQUIPMENT AT COLLINWOOD SHOP.

In this issue we present another descriptive article relating to the interesting Collinwood shops of the Lake Shore & Michigan Southern Railway, taking up this time the details of the electrical equipment for the lighting and the power for machine tools, cranes and turntables. Never before in the history of railroad development has such a complete electrical equipment been installed exclusively for service in a railroad shop installation. The advantages of electricity seem to have been secured—the lighting system is most complete and flexible, while the motor drives for the machine tools have not only made the tools independent, accessible and

economical, but also has very greatly reduced the floor space required for the large number of tools installed. The result has been a most complete utilization of the large floor space, with absolutely no sacrifice of accessibility or convenience.

It has been thought by some that space on a shop floor is by far too valuable to be utilized for lavatories and lockers, as was done in the Collinwood shops; however, at the present the space occupied by them is not needed, but if it should be as a result of unforseen growth, the task of removing them to a position outside the building in order to render available the space now occupied could not be very difficult and, viewed in this light, their location appears to be the result of unprecedented forethought by the officials who laid out the plans for the shop buildings.

MACHINE TOOL PROGRESS—FEEDS AND DRIVES.

The growing use of constant-speed motors, as gas and oil engines or synchronous alternating-current electric motors, for example, has rendered the utilization of mechanical methods for obtaining variable speeds an absolute necessity in industrial applications, and the use of mechanical devices for this purpose has become so important as to render valuable a thorough investigation of the various types and modified forms of such devices with reference to their mechanical and to their commercial merits. True variable-speed methods have long been in existence in the form of the cone pulleys and belt arrangement, the lathe back-gear, and the screw-cutting change-gear attachment, all of which have been identified with machine tools since the earliest days of engine lathe practice; but modern machine tool and industrial machinery practice have tended towards, and have come to demand, methods by which these changes of speed may be effected, with no interference to the transmission of power, as well as also with a much greater number of variations of speed within the speed range. This is particularly true of all modern machine tool practice identified with economic production and it is today the greatest desideratum in automobile and motor-car practice where constant-speed gas engines are so much used.

The article under the above title, of which the first of a series is begun on page 27 of this issue, is the result of an extended investigation of the subject made by our Associate Editor, Mr. C. W. Obert, prior to his connection with this journal. The subject is treated from an entirely practical standpoint with reference more to the service of the apparatus to the user than to the question of design. We hope that the results as set forth will do much to show what is necessary for the greatly needed increase of productivity of machine tools in railroad shops by indicating the direction toward which progress is tending in machine tool practice.

PIECEWORK AND THE WORKER.

"How to change the worker's attitude toward his work by means of a change in the system of apportioning the recompense for it would seem to be the foremost problem of the opening years of the new century."

This is the foundation of one of the best arguments for piece-work that has appeared. It is quoted from a paper entitled "Gift Propositions for Paying Workmen," read last month by Mr. Frank Richards before the American Society of Mechanical Engineers. The paper should be read by every employer of men. No attempt is made to present it in abstract here and space does not permit it to be printed in full.

The author discusses the modifications of the piece-work system known as the premium plan and the bonus system, taking issue with them on the ground that both give to the employer more than a proper share of the extra profits due to increased output through additional efforts on the part of workmen above what may be fairly expected of them for a day's work. Concrete examples are presented in detail to show that under these systems if a workman increases his product by one-half, and if for the extra half output he is paid at one-half the piece price, which would be determined by his day rate, the employer makes half the wages which would be paid to another workman, working under the old rate of production per man. This profit serves to reduce the cost per piece of the work done and makes the plan popular among manufacturers. Mr. Richards argues that the essential error in both of the systems referred to is in ignoring the strictly business relation of employer and employee. He asks: Why should the employer not pay in exact proportion to the quantity of work done?

The premium and bonus systems, and also straight piecework, have for their object the same thing, namely, increased output and reduced cost. They all aim to induce men by rewards to put forth their utmost endeavors. They differ, however, in one essential detail—in the character of the reward. Straight piece-work offers the whole reward to the workmen, while the other systems divide it more or less equally between the employer and the workmen. This division is made in order to lessen the temptation of the employer to cut the rates of the men, and it is an effort to secure the maximum effort of the men through the offer of the least possible inducement to secure that effort, and one which will prevent the earnings of the men from becoming uncomfortably large.

In other words, the premium and bonus systems offer an easy method of establishing prices and of correcting the effect of prices which are too high without actually cutting the rates—and rate-cutting is the rock on which piece-work is often wrecked. Mr. Richards says: "It is my view that for everything a workman can do there is a fair and equitable price, whatever the difficulty of determining that price, and that when a man does the work he should get the price." This seems to be pure and simple Honesty.

We cannot see wherein piece-work in any way fails to meet the need. Any plan which does not require dollars to be paid for pieces produced is sleight-of-hand and the men get the worst of it. The great and only trouble with piece-work seems to be the desire to cut the prices after they are once settled and the men get to making a little money. It is one thing to install piece-work in a shop and quite another thing to install it properly. The first requisite is to educate the men to have absolute confidence in their employer and to believe that at all times the employer will be fair to them. They should be made to feel that they are as much interested as the employer in getting the prices right. Where this plan is pursued piece-work prices are not put into effect by the hundreds, but gradually. Where it is done in this way it is successful and prices that are right do not need to be cut or changed until some new element or process comes up for consideration and calls for a new price because of a change in the conditions.

Again quoting from Mr. Richards: "The essential justice of the piece-work system remains, and it might be well worth while to investigate the mistakes, and worse, which have misdirected its application." In other words, piece-work should be tried fairly before substituting anything else for it.

Few of our readers are experienced with the premium system, but many of them are using the piece-work plan. Because this paper directs attention so forcibly to the importance of correct prices, it is important. Intelligent price fixing requires the attention of specialists and it behooves every establishment having the piece-work system or about to take it up to develop men who will understand and can develop the system properly.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

IV.

THE ELECTRICAL EQUIPMENT.

The application of an electrical system of distribution of power for the entire locomotive and car repair shops at Collinwood has rendered necessary a very complete and thoroughly equipped distribution system, which is necessarily of considerable magnitude inasmuch as all the lighting for the shops and yards and all the power for tool and crane driving in the shops, with the exception of a small percentage of compressed-air driven portable drills, hammers, etc., and the hydraulic riveter, are supplied electrically. All the motors and also the lamps, both arc and incandescent, are supplied by current from the same bus-bars in the central power plant, which was fully described on pages 332—339 of the November, 1902, issue of this journal. The distances from the power house to the various points of current consumption are not great, the only point to which current had to be transmitted outside of the shops themselves and the adjacent yard lighting being the roundhouse, which is lighted electrically and uses electric power for the turntable, so that the maximum distance of transmission is about 3,000 ft.; this distance renders the voltage of 240 volts sufficiently economical and it was preferable that no higher voltage be used for the sake of safety.

THE LIGHTING SYSTEM.

The electric lighting system for the shop buildings and yards comprises both arc and incandescent lighting, all lamps being fed from the same mains and at the same voltage, the dynamo voltage of 240 volts.

For the arc lighting enclosed arc lamps are used, operated at 120 volts each by connecting in groups of two in series across the 240-volt mains. Enclosed arcs are used not only for their high economy in the consumption of carbons and current but also on account of their nearly perfect diffusion of light, and the 120-volt lamp was used in preference to the lamp arranged for 240 volts on account of the better quality of light obtained from the lower voltage arc. In the erecting shop the arc lamps are distributed one at each space between pits, hung alternately at opposite ends; *i. e.*, in one space at the south side of the shop and in the next space at the machine-shop side. This same arrangement of arc lamps is carried out in the boiler shop, while in the machine shop arcs are hung in every other bay on the girder in the middle between the heavy tool and light tool sections. The arc lamps were supplied by the Fort Wayne Electric Works, Fort Wayne, Ind., under a guarantee as to performance, each lamp being provided with an automatic attachment which will keep it burning if its mate in the series burns out.

An incandescent lamp is provided at every machine tool, being supported on a swinging bracket fastened to the tool and usually fed by a flexible double-conductor insulated cord hanging slack from mains on the roof-trusses above. The lamps on the direct motor-driven tools are, however, fed with current from the power circuit for the motor on that tool. The incandescent lamps used are all the special long-filament 240-volt lamps, connected singly across the mains. Between the pits in the erecting shop there are lamp-posts erected, one in the center of each bench, with four swinging brackets at their tops and a four-light cluster just below, at about 7 ft. above the floor; extension-cord plugs may be inserted in any socket of the brackets or of the cluster for portable lamps in any location desired; also, 25-ampere capacity extension-plug receptacles are provided at every post, so that flexible cords may be run for 5 horse-power portable motors at any point desired, feeding from the lighting mains, and extra receptacles from which to run extension-cord portable lamps are placed at every post in the shop.

The feeders for the lighting system are run from their respective main switches on the feeder panels of the switchboard in the power-house under ground, through basement and then the piping tunnel, to the southeast corner of the locomotive shop, and enter two distribution boxes. From these, feeders run on the wall of the building at a height of 16 ft. above the floor to distributing panel boards placed at convenient locations from which to lead the mains separately to the lights fed.

From the panel boards the arc and incandescent light circuits are run separately. There are a few circuits arranged independently for all-night arc lamps which are scattered throughout the buildings and outside. All the fuses used throughout the entire system are the "Noark" cartridge-type enclosed fuses, manufactured by the H. W. Johns-Manville Company, New York.

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Feeder cables lead from the switchboard in the power house through the piping tunnel to six distributing boxes in the locomotive shop, four of which are located at intervals along the length of the machine-shop section and the other two of which are spaced on the south wall of the erecting shop. The "inside" feeders for the intermediate voltages of the multiple voltage system, lead only into the four machine shop boxes, which are arranged in two pairs so that for each pair each intermediate wire to one box is simply tapped off from the similar one to the other so that the load on one box assists in balancing that on the other without the power being compelled to return to the power-house switchboard for the balancing effect. From the distribution boxes mains are run to eleven tablet, or panel, boards, situated at convenient points around the shop, and from these boards a separate circuit is carried to each tool, except for some long runs, such as that to the turn-table outside the north side of the shop, where tap-offs have been allowed. The engraving on the opposite page shows the general arrangement of one of these tablet boards located on a column in the machine shop.

The circuits to the tools in the heavy machine bay, over which there is a crane, and to a number of direct-connected tools in the light machine shop, are run underground, the wires being passed through loricated pipe, which is carried in a groove in the 3-in. plank floor and covered up by the 1-in. maple flooring on top. This system was adopted in preference to any elaborate system of junction boxes under the floor, as it was found that in order to keep the conduits out of the way as much as possible, and at the same time have the controllers in the most convenient position for the men operating the tools, it is necessary *not* to bring the pipe up within a few feet of the controller, but within a few inches of its best position.

This system of tablet boards has not been adhered to rigidly—in the erecting and boiler shops the tree system of "tap-off" wiring has been used. Leads are run between each pit in the erecting shop of sufficient capacity to operate two 5-h.p. portable motors in each of two pits on either side of a center track. Also these wires take care of the incandescent lighting in the erecting shop.

All the tools which are gear-connected to their motors are provided with single-pole overload-release circuit breakers, located at the sides, or back, out of reach so that they will not be thrown out wrongfully. This not only protects each motor from injurious overload, but prevents any general shut-down of the entire plant in case of accident to any tool. Each fuse on the tablet boards is considerably above the capacity of the circuit breaker on its circuit, being of sufficient size to allow for a failure of the circuit breaker and a heavy overload on the motor before it blows. Group motors on which

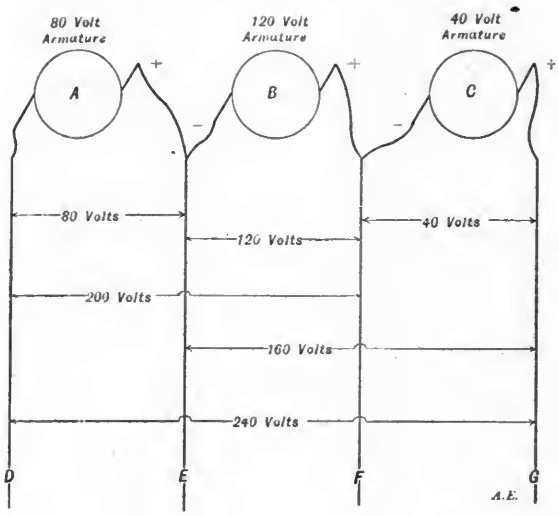

DIAGRAM SHOWING PRINCIPAL CONNECTIONS AND THE COMBINATIONS POSSIBLE WITH THE MULTIPLE VOLTAGE SYSTEM.

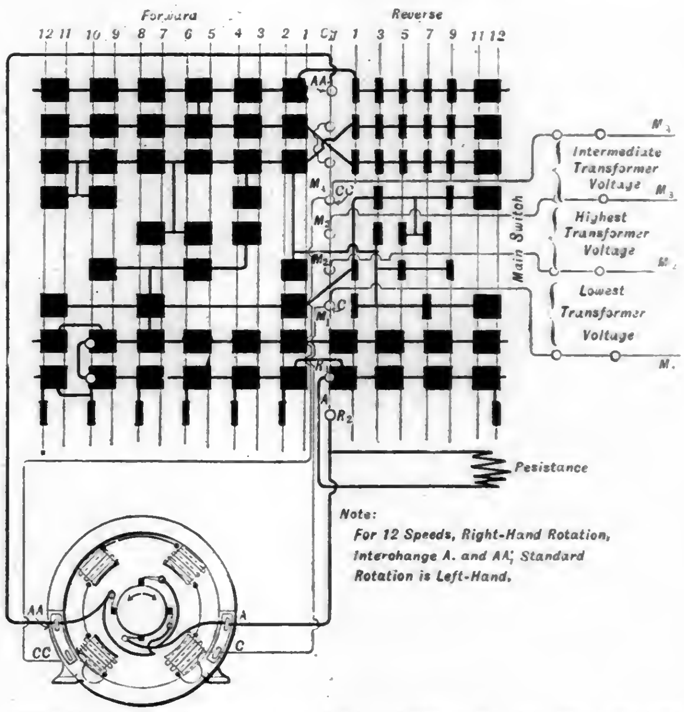

DIAGRAM OF CONNECTIONS OF THE CONTROLLER FOR THE MULTIPLE VOLTAGE SYSTEM.

VIEW OF A TYPICAL TABLET BOARD IN THE MACHINE SHOP, FROM WHICH FOUR MOTOR CIRCUITS ARE FED.

(Crocker-Wheeler motor-drive applied to a machine tool shown in background, showing location of controller, circuit-breaker, resistance box, etc.)

COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

an excessive load is rather likely to occur are not provided with circuit breakers at all, but simply with fuses, which fuses are, however, of a capacity 50 per cent. above the rated horse-power of the motor; they are not intended to protect the motor against overload, except in case of its being extreme, such as might occur from a breakdown.

This principle of fusing far above the rated capacity of the motor attached to the circuit has been carried out throughout the entire electrical installation, using the fuse simply as a protection against a breakdown or short circuit. All fuses on the power circuits are also inclosed fuses of the "No-ark" type to enable them to be replaced with the least possible loss of time. All the wires in tunnel and open work are single-braid weatherproof insulated, and those under-

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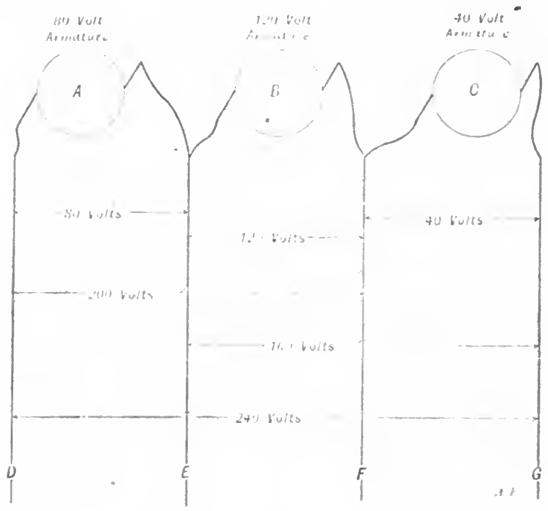
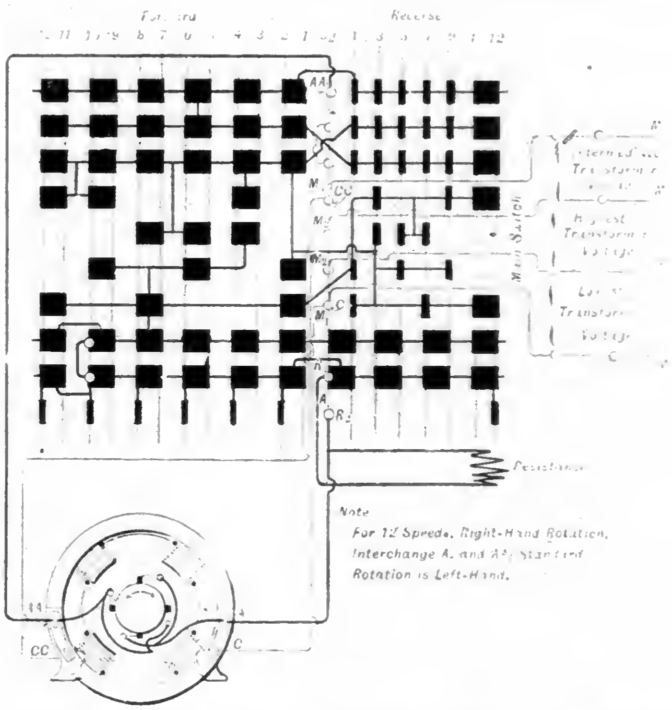


DIAGRAM SHOWING PRINCIPAL CONNECTIONS AND THE COMBINATIONS POSSIBLE WITH THE MULTIPLE VOLTAGE SYSTEM.



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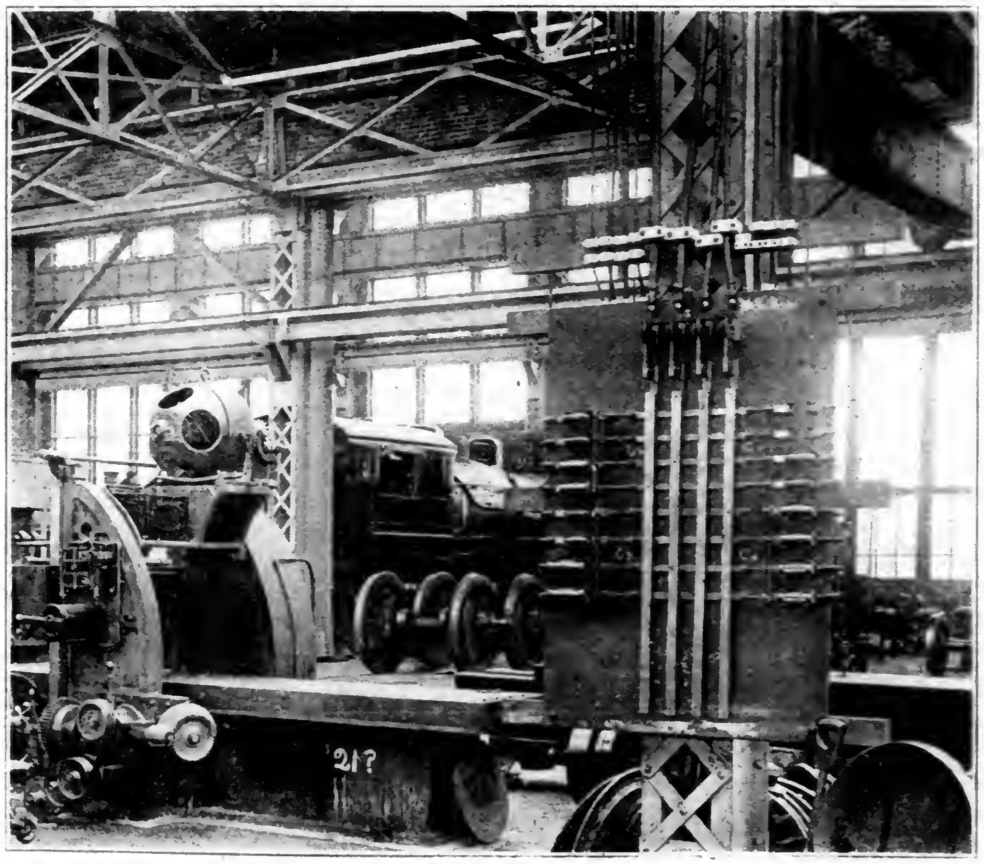


VIEW OF A TYPICAL TABLET BOARD IN THE MACHINE SHOP, FROM WHICH FOUR MOTOR CIRCUITS ARE FED.

(Crocker-Wheeler motor-drive applied to a machine tool shown in background, showing location of controller, circuit-breaker, resistance box, [illegible]

COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

an excessive load is rather likely to occur are not provided with circuit breakers at all, but simply with fuses, which fuses are, however, of a capacity 50 per cent. above the rated horse-power of the motor; they are not intended to protect the motor against overload, except in case of its being extreme, such as might occur from a breakdown.

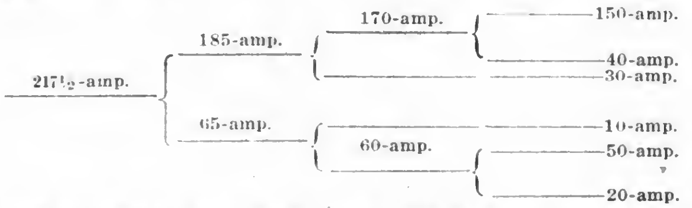
This principle of fusing far above the rated capacity of the motor attached to the circuit has been carried out throughout the entire electrical installation, using the fuse simply as a protection against a breakdown or short circuit. All fuses on the power circuits are also inclosed fuses of the "No-ark" type to enable them to be replaced with the least possible loss of time. All the wires in tunnel and open work are single-braid weatherproof insulated, and those under-

ground are rubber-covered. The circuit breakers used on the tools are the midget senior type made by the Cutter Company, Philadelphia, Pa.

This tablet-board system is about 10 per cent. more expensive than the tree or "tap-off" system, in which mains are run direct from distribution boxes and tap-offs lead off to each tool; but it has many important advantages. On the tablet boards are all the fuses for each circuit leading to a motor, so that if a fuse for any tool blows, the place to look for it is known and it can be instantly replaced. As each tool has a separate circuit, every one to which it is necessary to run the wires underground has all its wires in one piece of loricated pipe, so that if any defect develops in the insulation of the wires, there is no ground, but a short circuit, and it is instantly located and the wires can be drawn out and replaced.

There are also no fuses underground. Where shops are wired on the tap-off system underground without fuses, if a short circuit occurs the fuse will blow back on the distributing box, or switchboard, and all tools on that branch will be idle until it is replaced. Here the voltage at the tool is also far more constant, as one heavy tool near the distributing box cannot lower the voltage for all tools beyond it, but as the mains are carried near to the group of tools connected to them they all lower in voltage alike.

In calculating sizes of wires, a difficulty is occasioned by the fact that in mains and feeders the amperes can be reduced per horse-power on account of the number of tools rendering variations in power less noticeable and also on account of not all the tools being in use at once. At the same time the capacity must of course be sufficient to take care of the largest, or several of the largest, tools without excessive load on the wires. In the case of the feeders, this is not serious, as there are sufficient tools to average up satisfactorily, but in the case of the mains no rule depending upon amperes per horse-power and load factors is satisfactory. Therefore a progressively decreasing quantity system of calculating was devised in which all circuits are laid out on the branch system, and they are then combined in pairs, successively, back to the distributing box; in each combination the amperes on the joining wire are determined by adding half the smaller branch to the larger, as indicated by the sample diagram appended below:



By this system the heavy load is always taken care of and a fair margin is added to take care of the proportion of the smaller loads that may be in use. Of course, a different factor than one-half may be taken, as one-third, for instance, but it was found that by taking 4 to 7 amperes per horse-power in circuits and then reducing to 3½ or 3 on feeders and combining all circuits clear back to switchboard with the factor one-half, that the same results were obtained for feeders as with best information otherwise available. This system, which was devised by Mr. H. H. Vaughn, was found very rapid and satisfactory. Of course, different results can be obtained by combining in different ways, but the error is not large enough in this case to be serious. The feeders were figured to give 5 per cent. drops to centers of power, and then the circuits were adjusted to make the drops at tools not over 5 per cent.

The engravings upon page 25 show typical arrangements of motors for the motor drives in the machine shop. The illustration on page 23, which shows the rear of a planer-type milling machine, is particularly well adapted to indicate the convenient and compact arrangement possible for the motor, controller, resistance box and circuit-breaker.

THE MULTIPLE VOLTAGE SYSTEM.

In order to obtain variable speeds from the motors used upon the direct-driven tools, the multiple voltage system of the Crocker-Wheeler Company was installed for the speed controls, which system was referred to in relation to the generating equipment in the description of the power plant in our November number. This system consists essentially of several sources of current supply at different voltages, each differing by 40 volts, which may be each fed to the motor separately or in combinations, each different voltage and combination giving a different motor speed. This is accomplished as shown in the accompanying diagram, the armatures of the balancing rotary transformer being connected up in series with lead wires tapped off between each two and outside. This is, of course, merely an extension of the idea of the familiar Edison three-wire system, so much used in electric lighting; in this case, however, four wires are used and the voltages in the various branches of the system are not equal.

The changing of speeds of the motors is made simple by the use of controllers which, for the different positions of their handles, connect their motors to the various sources of supply and then to the various combinations in succession. Thus, for the starting position of the handle, a motor is connected to C (40 volts) only, and in later steps to A (80 volts) only, and then to B (120 volts) only; for still higher speeds the motor is connected in succession to B and C combined (160 volts), A and B combined (200 volts), and at last to A, B and C combined (240 volts), the highest voltage, which is taken from the "outside," or main lead, wires, giving the total dynamo voltage and is then independent of the balancing transformer. Each voltage applied to the motor gives it a different constant speed, 40 volts giving the lowest speed, used for starting only, and the other voltages, higher speeds up to 240 volts, the highest. With the Crocker-Wheeler controllers, as applied in this installation, intermediate speeds are made available between those offered by the various voltages and combinations by an armature resistance, giving 20 volts drop, inserted in the armature circuit at every other controller step. The diagram on page 23 indicates the arrangement of the complete connections for a controller governing a motor. The four small circles shown at M_1, M_2, M_3 and M_4 represent fingers of the controller which lead the supply current into the contacts on the drum. Each vertical line in the controller diagram represents a step of the controller for a certain definite speed, of which there are 12 forward and 6 reverse. The complete connections through the controller to the motor may be traced for each controller speed in the diagram by considering the 9 small circles, R_2, R_1, M_1, M_2, M_3, M_4, O, O and A A_1 (which represent the contact fingers of the controllers), as moved along to coincidence with the various vertical lines, in each of which positions they will be each in contact with a group of the contact plates (represented by the heavy black squares) furnishing the required connections. The first step connects the motor into the lowest voltage in series with the resistance, giving the 20-volt drop; the second step merely cuts this resistance out of the circuit; the third step connects up the next higher voltage again in series with the same resistance; the fourth merely cuts out the resistance again; and so on to the highest speed.

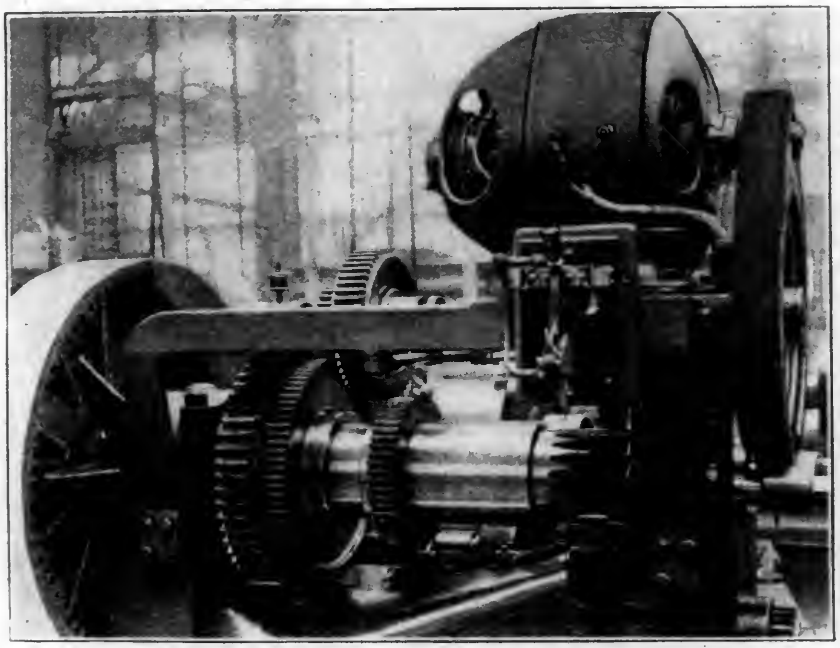
A notable feature of the Crocker-Wheeler controller is the fact that in passing from one step to the next in either direction, absolute contacts are ensured by a spring mechanism causing quick jumps from one position to another; this prevents the handle from remaining half way accidentally. Also the use of the resistance giving the 20-volt drop goes a great ways to effect smoothness in changes of speed. If the changes were made from one voltage to the next higher (which is in all cases a difference of 40 volts) the result would be a mechanical shock to the motor with each change; but the resistance reduces the jump one-half and thus effectually serves as a "cushion" to the motor at each change.

Below is presented in detail the information regarding the Niles electric cranes, which serve the various departments of the locomotive shop. This supplements the article that appeared last month. In the the following issue of this journal the information will be given regarding the machine tool equipment and methods of driving.

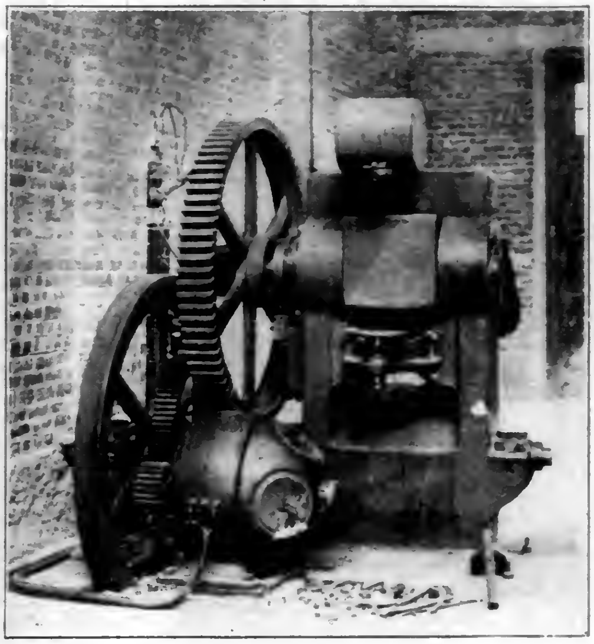
TRAVELING CRANES.

The arrangement of the four main electric cranes running full length of the locomotive shop are indicated in the drawings, pages 369-371 of our December, 1902, issue. The erecting shop is served by two cranes having different tracks, one a 100-ton crane with two 50-ton trolleys, and the other a 10-ton crane with a single trolley. The 100-ton crane, which runs on the upper track, has a span of 65 ft. 6 ins., with the tracks 38 ft. 4 ins. above the floor, while the 10-ton crane, on the lower track, has a 62-ft. 8-in. span, with tracks 26 ft. 3 ins. above floor.

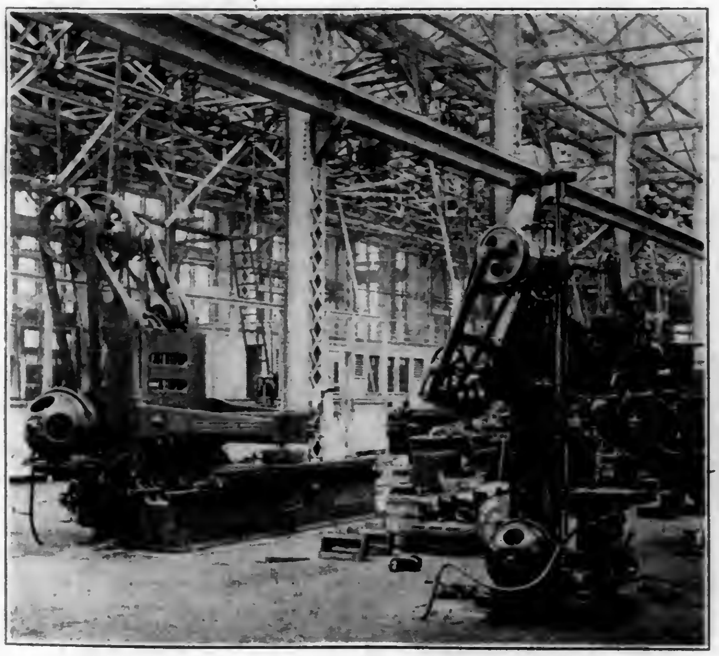
The lift of either hook of the 100-ton crane is 35 ft. 2 ins., which is sufficient to permit lifting of one locomotive entirely over the others. The test load submitted to each trolley of this crane was 125,000 lbs., its rated capacity being 100,000 lbs. each. The height over all of the crane above runway rails is 10 ft. 3½ ins. This crane is equipped with five motors, all operated at the dynamo voltage of 240 volts on the main two-wire system. The two main hoists are each equipped with 45 h. p. motors giving a hoisting speed of 10 ft. per minute at full load and 25 ft. per minute at no load; the trolleys each have 10 h. p. traversing motors capable of giving a trolley



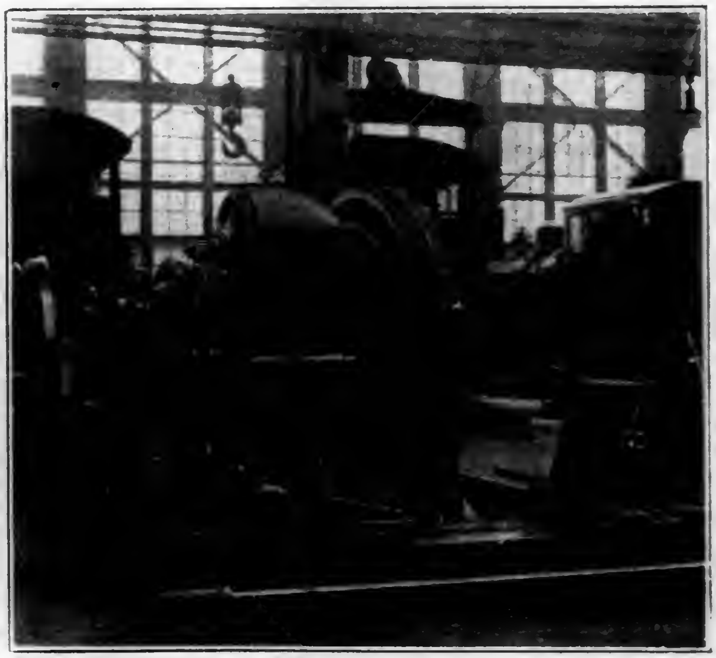
DIRECT DRIVE ON A 28-INCH POND ENGINE LATHE.
(Motor supported on a specially designed framework above the headstock.)



DRIVE FOR A CINCINNATI PUNCH AND SHEAR WORKS BAR SHEAR.
(Showing convenient arrangement of motor and method of leading in wires.)



BELTED DRIVE FOR A DETRICH & HARVEY OPEN-SIDE PLANER AT LEFT—DIRECT DRIVE ON A BICKFORD RADIAL DRILL AT RIGHT.



DIRECT DRIVE ON AN 84-INCH NILES WHEEL LATHE.
(Showing convenient arrangement of motor and controller.)

TYPICAL INDIVIDUAL MOTOR DRIVES.

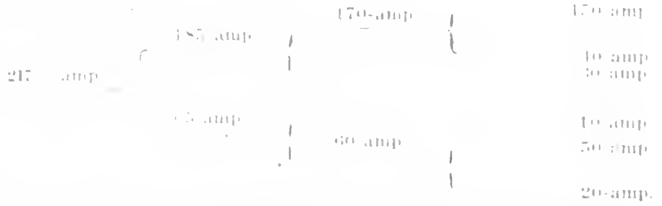
COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

ground are rubber-covered. The circuit breakers used on the tools are the midget senior type made by the Cutter Company Philadelphia, Pa.

This tablet-board system is about 10 per cent. more expensive than the tree or "tap-off" system, in which mains are run direct from distribution boxes and tap-offs lead off to each tool; but it has many important advantages. On the tablet boards are all the fuses for each circuit leading to a motor, so that if a fuse for any tool blows, the place to look for it is known and it can be instantly replaced. As each tool has a separate circuit, every one to which it is necessary to run the wires underground has all its wires in one piece of loricated pipe, so that if any defect develops in the insulation of the wires, there is no ground, but a short circuit, and it is instantly located and the wires can be drawn out and replaced.

There are also no fuses underground. Where shops are wired on the tap-off system underground without fuses, if a short circuit occurs the fuse will blow back on the distributing box, or switchboard, and all tools on that branch will be idle until it is replaced. Here the voltage at the tool is also far more constant, as one heavy tool near the distributing box cannot lower the voltage for all tools beyond it, but as the mains are carried near to the group of tools connected to them they all lower in voltage alike.

In calculating sizes of wires, a difficulty is occasioned by the fact that in mains and feeders the amperes can be reduced per horse-power on account of the number of tools rendering variations in power less noticeable and also on account of not all the tools being in use at once. At the same time the capacity must of course be sufficient to take care of the largest, or several of the largest, tools without excessive load on the wires. In the case of the feeders, this is not serious, as there are sufficient tools to average up satisfactorily, but in the case of the mains no rule depending upon amperes per horse-power and load factors is satisfactory. Therefore a progressively decreasing quantity system of calculating was devised in which all circuits are laid out on the branch system, and they are then combined in pairs, successively, back to the distributing box; in each combination the amperes on the joining wire are determined by adding half the smaller branch to the larger, as indicated by the simple diagram appended below:



By this system the heavy load is always taken care of and a fair margin is added to take care of the proportion of the smaller loads that may be in use. Of course, a different factor than one-half may be taken, as one-third, for instance, but it was found that by taking 4 to 7 amperes per horse-power in circuits and then reducing to $3\frac{1}{2}$ or 3 on feeders and combining all circuits clear back to switchboard with the factor one-half, that the same results were obtained for feeders as with best information otherwise available. This system, which was devised by Mr. H. H. Vaughn, was found very rapid and satisfactory. Of course, different results can be obtained by combining in different ways, but the error is not large enough in this case to be serious. The feeders were figured to give 5 per cent. drops to centers of power, and then the circuits were adjusted to make the drops at tools not over 5 per cent.

The engravings upon page 25 show typical arrangements of motors for the motor drives in the machine shop. The illustration on page 23, which shows the rear of a planer-type milling machine, is particularly well adapted to indicate the convenient and compact arrangement possible for the motor, controller, resistance box and circuit-breaker.

THE MULTIPLE VOLTAGE SYSTEM.

In order to obtain variable speeds from the motors used upon the direct-driven tools, the multiple voltage system of the Crocker-Wheeler Company was installed for the speed controls, which system was referred to in relation to the generating equipment in the description of the power plant in our November number. This system consists essentially of several sources of current supply at different voltages, each differing by 40 volts, which may be each fed to the motor separately or in combinations, each different voltage and combination giving a different motor speed. This is accomplished as shown in the accompanying diagram, the armatures of the balancing rotary transformer being connected up in series with lead wires tapped off between each two and outside. This is, of course, merely an extension of the idea of the familiar Edison three-wire system, so much used in electric lighting; in this case, however, four wires are used and the voltages in the various branches of the system are not equal.

The changing of speeds of the motors is made simple by the use of controllers which, for the different positions of their handles, connect their motors to the various sources of supply and then to the various combinations in succession. Thus, for the starting position of the handle, a motor is connected to C (40 volts) only, and in later steps to A (80 volts) only, and then to B (120 volts) only; for still higher speeds the motor is connected in succession to B and C combined (160 volts), A and B combined (200 volts), and at last to A, B and C combined (240 volts), the highest voltage, which is taken from the "outside," or main lead, wires, giving the total dynamo voltage and is then independent of the balancing transformer. Each voltage applied to the motor gives it a different constant speed, 40 volts giving the lowest speed, used for starting only, and the other voltages, higher speeds up to 240 volts, the highest. With the Crocker-Wheeler controllers, as applied in this installation, intermediate speeds are made available between those offered by the various voltages and combinations by an armature resistance, giving 20 volts drop, inserted in the armature circuit at every other controller step. The diagram on page 23 indicates the arrangement of the complete connections for a controller governing a motor. The four small circles shown at M_1, M_2, M_3 and M_4 represent fingers of the controller which lead the supply current into the contacts on the drum. Each vertical line in the controller diagram represents a step of the controller for a certain definite speed, of which there are 12 forward and 6 reverse. The complete connections through the controller to the motor may be traced for each controller speed in the diagram by considering the 9 small circles, R_1, R_2, M_1, M_2, M_3, M_4, O, O and A A_1 (which represent the contact fingers of the controllers), as moved along to coincidence with the various vertical lines, in each of which positions they will be each in contact with a group of the contact plates (represented by the heavy black squares) furnishing the required connections. The first step connects the motor into the lowest voltage in series with the resistance, giving the 20-volt drop; the second step merely cuts this resistance out of the circuit; the third step connects up the next higher voltage again in series with the same resistance; the fourth merely cuts out the resistance again; and so on to the highest speed.

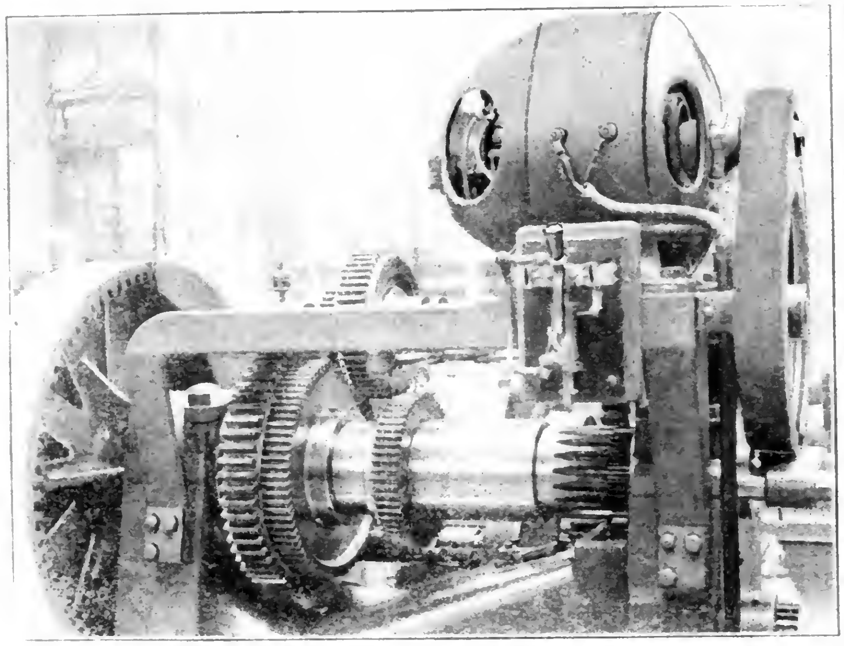
A notable feature of the Crocker-Wheeler controller is the fact that in passing from one step to the next in either direction, absolute contacts are ensured by a spring mechanism causing quick jumps from one position to another; this prevents the handle from remaining half way accidentally. Also the use of the resistance giving the 20-volt drop goes a great ways to effect smoothness in changes of speed. If the changes were made from one voltage to the next higher (which is in all cases a difference of 40 volts) the result would be a mechanical shock to the motor with each change; but the resistance reduces the jump one-half and thus effectually serves as a "cushion" to the motor at each change.

Below is presented in detail the information regarding the Niles electric cranes, which serve the various departments of the locomotive shop. This supplements the article that appeared last month. In the the following issue of this journal the information will be given regarding the machine tool equipment and methods of driving.

TRAVELING CRANES.

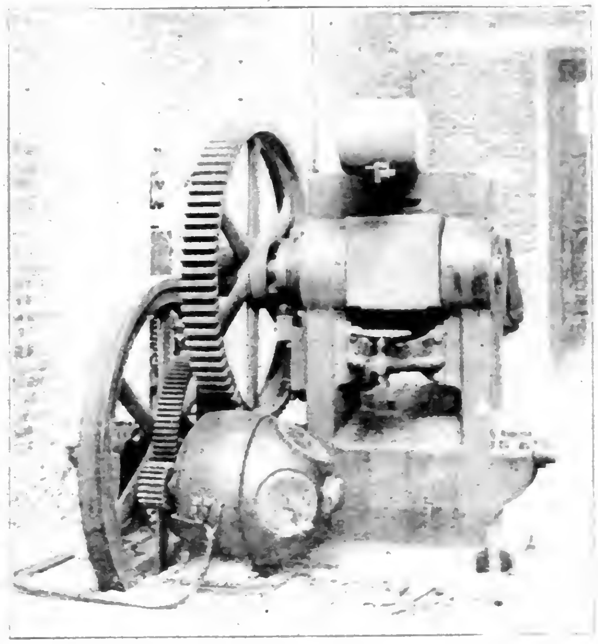
The arrangement of the four main electric cranes running full length of the locomotive shop are indicated in the drawings, pages 369-371 of our December, 1902, issue. The erecting shop is served by two cranes having different tracks, one a 100-ton crane with two 50-ton trolleys, and the other a 10-ton crane with a single trolley. The 100-ton crane, which runs on the upper track, has a span of 65 ft. 6 ins., with the tracks 38 ft. 4 ins. above the floor, while the 10-ton crane, on the lower track, has a 62-ft. 8-in. span, with tracks 26 ft. 3 ins. above floor.

The lift of either hook of the 100-ton crane is 35 ft. 2 ins., which is sufficient to permit lifting of one locomotive entirely over the others. The test load submitted to each trolley of this crane was 125,000 lbs., its rated capacity being 100,000 lbs. each. The height over all of the crane above runway rails is 10 ft. $3\frac{1}{2}$ ins. This crane is equipped with five motors, all operated at the dynamo voltage of 210 volts on the main two-wire system. The two main hoists are each equipped with 45 h. p. motors giving a hoisting speed of 10 ft. per minute at full load and 25 ft. per minute at no load; the trolleys each have 10 h. p. traversing motors capable of giving a trolley



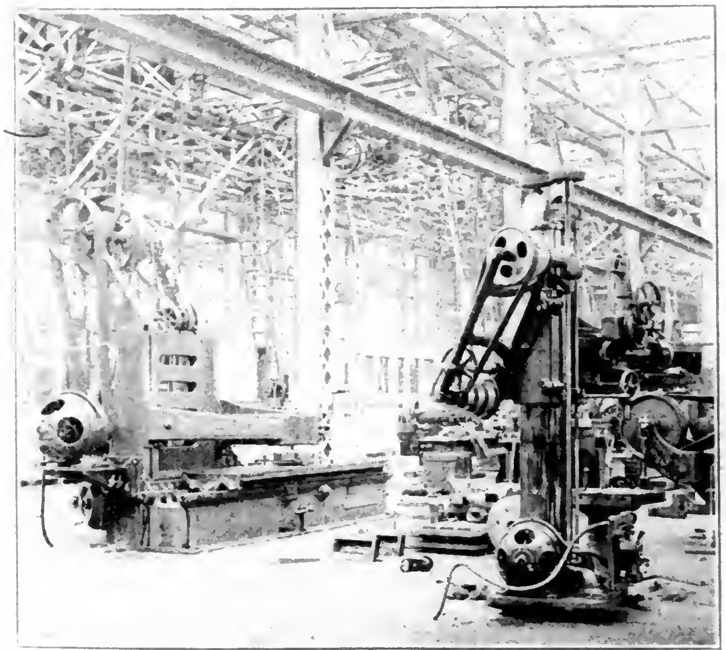
DIRECT DRIVE ON A 28-INCH POND ENGINE LATHE.

(Motor supported on a specially designed framework above the headstock.)

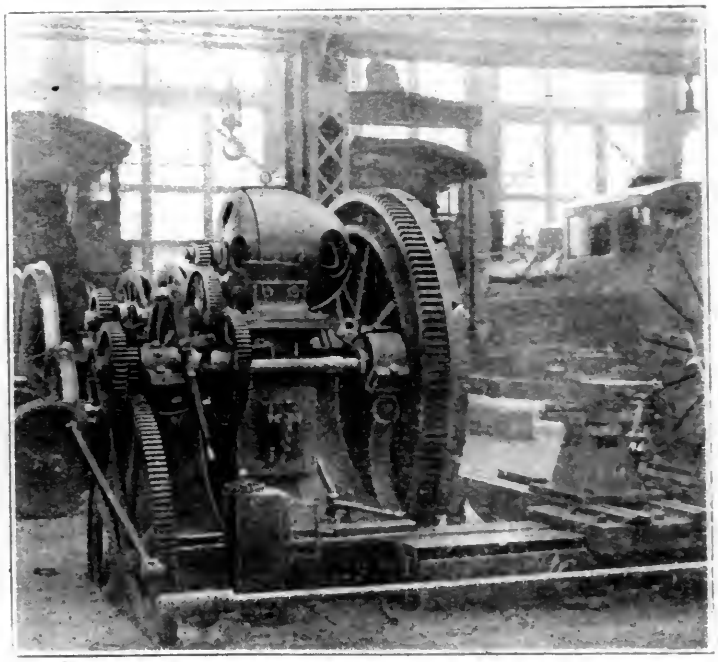


DRIVE FOR A CINCINNATI PUNCH AND SHEAR WORKS BAR SHEAR.

(Showing convenient arrangement of motor and method of leading in wires.)



BELTED DRIVE FOR A DIETRICH & HARVEY OPEN-SIDE PLANER AT LEFT—DIRECT DRIVE ON A BICKFORD RADIAL DRILL AT RIGHT.



DIRECT DRIVE ON AN 84-INCH NILES WHEEL LATHE.

(Showing convenient arrangement of motor and controller.)

TYPICAL INDIVIDUAL MOTOR DRIVES.

COLLINWOOD SHOPS, LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

speed of 75 ft. per minute at full load and 100 ft. per minute at no load; the bridge is equipped with a 45 h. p. motor giving a full load speed of 150 ft. and no load speed of 200 ft. per minute.

The 10-ton crane has a 26-ft. lift of the main hook, its test load having been 25,000 lbs., and its height over all above the runway rails is 7 ft. 3 ins. Its main hoist has a 20 h. p. motor, giving a hoisting speed of from 20 ft. to 50 ft. per minute from full load to no load. The trolley has a 2½ h. p. traversing motor, with a speed of from 125 ft. to 160 ft., and the bridge is equipped with a 20 h. p. motor, giving a crane speed of 300 ft. to 375 ft. per minute.

The crane serving the boiler shop is a 30-ton crane with two 15-ton trolleys having a lift of main hook of 34 ft. 6 ins. Its span is 74 ft. 6 ins. and its height over all is 8 ft. 3½ ins. above runway rails. The test load of each trolley was 37,500 lbs. Each main hoist has a 20 h. p. motor giving a hoisting speed of 14 to 30 ft. per minute from full to no load; the traversing motors of each trolley are 2½ h. p. motors giving speeds from 110 to 150 ft. per minute from full to no load; the bridge motor is 30 h. p., giving speeds from 250 to 300 ft. per minute.

The 7½-ton crane in the heavy tool section of the machine shop has for its main hoist a 20 h. p. motor, giving a hoisting speed of 20 to 50 ft. per minute from full to no load; for the traverse of the trolley a 2½ h. p. motor, giving speeds from 125 to 160 ft., and for the bridge a 20 h. p. motor, giving speeds from 300 to 375 ft. per minute. Its span is 46 ft. 7 ins. and its height over all is 5 ft. 6 ins. above the runway rails, the test load of the hoist being 18,750 lbs.

All cranes have cut gears and the hoisting gear runs in oil, with dust-proof covering boxes. They were all supplied by the Niles, Bement, Pond Company, the well-known machine tool and crane manufacturers.

There are also three 1-ton hand-power traveling cranes with 17 and 18 ft. spans and short local travels in the light tool section of the machine shop. They all run on tracks 20 ft. 9 ins. above floor and are all arranged to serve local heavy tools. The crane in the riveting tower of the boiler shop is a hydraulic crane supplied by same pressure as to the riveter; its hoist is controlled by a hydraulic cylinder on the floor and its traverse and trolley motion is by hand. It was furnished by the Niles, Bement, Pond Company, together with the riveter.

An interesting special portable drilling machine has recently been placed in service at the works of the Dodge Manufacturing Co. which is adapted for saving time in mounting for drilling of the hub flanges for large segmental fly-wheels. The drilling machine is the standard radial drill of the latest type manufactured by the Bickford Drill and Tool Co., of Cincinnati, O., with the exception of the absence of the base, and other changes made necessary by the direct motor drive. The base has been entirely omitted and replaced by an extension of the column at its lower end into a short, slightly tapering stump intended to fit corresponding bushings which in turn, will fit the bores of the various sizes of wheel hubs. The electric drive consists of a constant speed motor with a vertical armature shaft and is mounted directly on top of the drill column, so that not only is it direct-connected to the gearing of the machine, but also it is in a position offering the least possible hindrance to handling and operation. The drive is through nests of gears which may be changed by hand levers to give eight changes of speed. The tool is mounted very quickly by means of the traveling crane in the bore of the wheel hub lying on its side, after which the spoke bolt holes may be drilled and reamed with the greatest facility. For rapid machining, together with economy of time in locating, this form of machine commends itself and suggests the possibilty of similar applications in locomotive repair work.

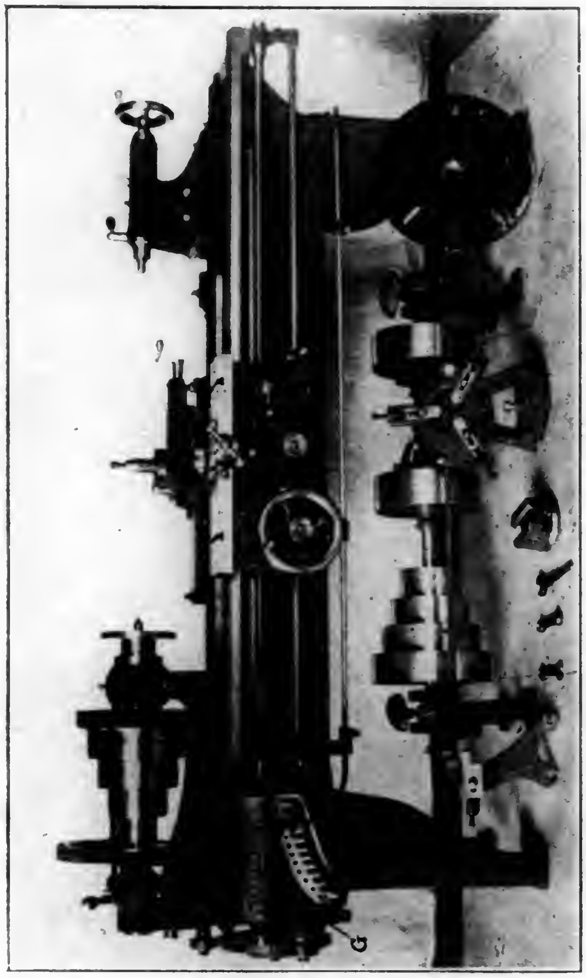


FIG. 1.—HENDEY-NORTON ENGINE LATHE, SHOWING ARRANGEMENT OF GEAR-BOX.

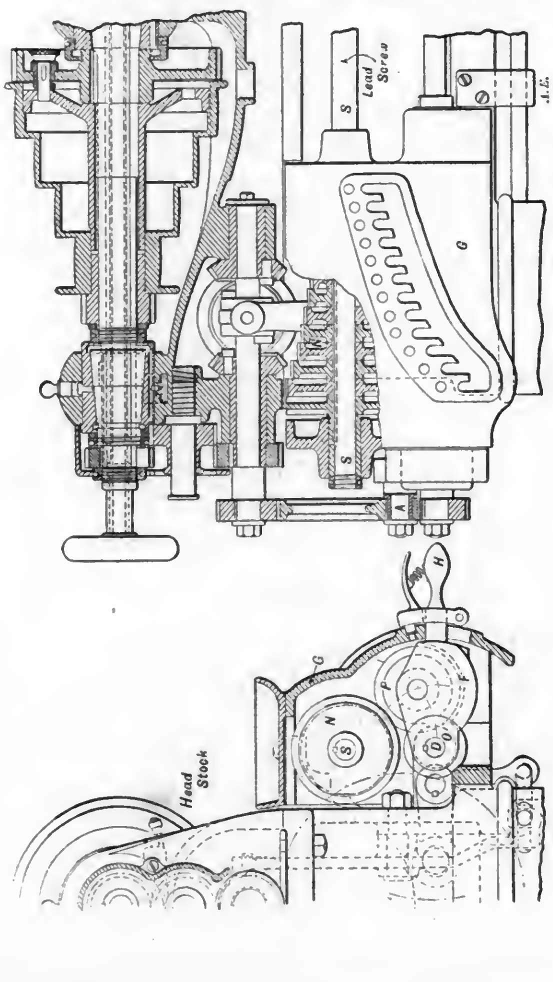


FIG. 3.—CROSS AND PART LONGITUDINAL SECTIONS OF HENDEY-NORTON GEAR-BOX.

MACHINE TOOL PROGRESS—FEEDS AND DRIVES.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

BY C. W. OBERT.

I.

The term variable-speed power-transmission device as here used is intended to refer to a self-contained mechanical arrangement interposed between a motor, or driving shaft, and the driven shaft, or machine, whereby power in the form of rotative motion may be delivered from the driving source to the receptive source at speeds which may easily be changed without removing belts or changing gears in the sense conveyed by the "change gear" method for screw cutting in engine lathe practice. The ideal limitation of the variable-speed device is, of course, the arrangement whereby the speed of transmission may be varied through an *infinite number of*

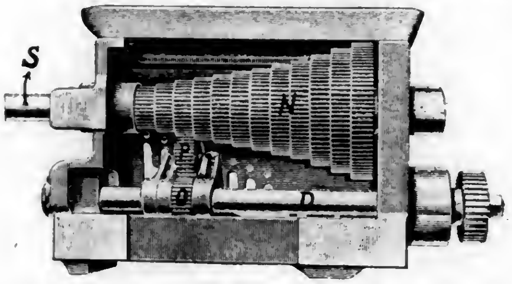


FIG. 2.—REAR VIEW OF GEAR-BOX, SHOWING GEARING.

variations, instantaneously, easily and *without any interruption* to the transmission of the power. Such an achievement has been incapable of realization in practice, even though many attempts have been made in this direction with some degree of success, especially with devices using the frictional-driving method of transmission. The greatest development has, however, been along the more practical line of the positive-drive method of transmission, and along this line many attempts have been made to perfect devices. It is hoped to be able to herein show along what lines true progress has been made and where mechanical limitations seem to have checked desired progress in other lines.

An examination of all the methods of obtaining variable speeds reveals the two general divisions of the subject according to the agency employed in transmitting the power, viz.: mechanical and electrical. Then the mechanical division is also divisible into subdivisions, according to the mechanism employed in the transmission, viz.: the positive-drive class, using gears, and the friction-drive class. In the positive-drive division of the mechanical methods only a very limited number of attempts have been made toward the design of mechanisms in which the speed may be changed without interruption of the transmission; in fact, the entire development of variable-speed apparatus in machine tool practice may be traced back to the well-known "back gear" method of obtaining two different speeds at the drill or lathe spindle from a constant-speed countershaft drive, which method involves necessarily a cessation of the transmission of power in changing speeds because toothed gears are used. The principal application of the mechanical gear-drive variable-speed device in machine tool practice is that of driving feed mechanisms; the use of the modern heavy lathes for hard-driven service in efforts toward increased profit-making has rendered belt-driven feeds undesirable and practically *requires* positive-geared feeds of wide ranges of speed, although it is by no means essential that there shall be no interruption of power while changing the speed of feed.

One of the earliest examples of a variable-speed feed mechanism of the gear-drive type is that which is applied by the Hendey Machine Company, Torrington, Conn., to their Hendey-Norton lathes. Their arrangement of gears is that of a nest of several gears of different diameters mounted on the driven shaft and a small spur gear revolving with, and movable lengthwise on, the parallel driving shaft, which spur gear is capable of being thrown into mesh with any gear of the nest. Fig. 1 shows a general view of an 18-in. Hendey-Norton lathe with this gearing device attached as shown at G. Fig. 2 is a rear view of the device detached from the lathe, and Fig 3 shows it in section. N is the nest of gears, all keyed to the lead screw shaft S, and D is a splined driving shaft parallel to the shaft, S, which receives its motion from the headstock spindle through gearing at A, in the usual way. Surrounding the shaft D is a bracket, or frame, F, Figs. 2 and 3, inclosing the pinion O, which feathers into and thus revolves with the driving shaft D, and also there is carried in this frame another pinion, P, which is mounted permanently in mesh with pinion O. This frame is controlled by the handle H. Fig. 3, outside the case, so that by moving the latter along the lower side of the large lateral slot in the front side of the case, the pinion P may be brought adjoining any of the gears in the nest; and then when it is desired to place it into mesh with any gear of the nest, the handle H is raised into the small vertical slot corresponding to that gear and locked

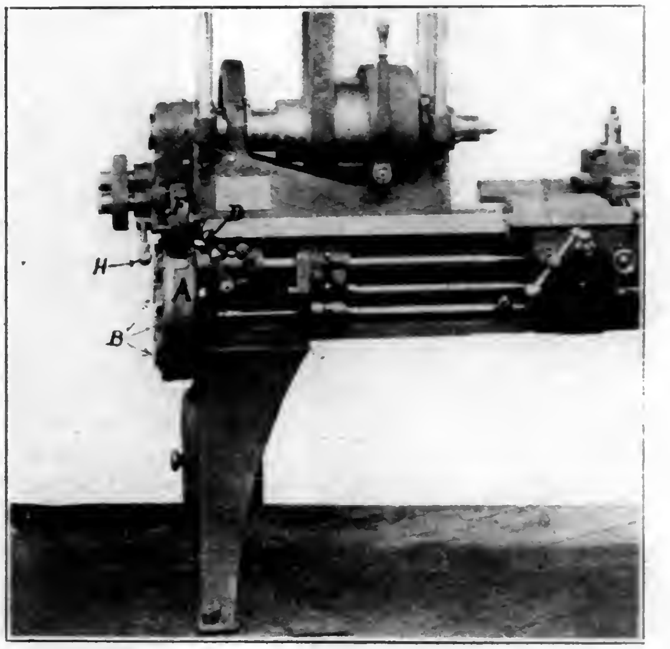


FIG. 4.—IDEAL LATHE, SPRINGFIELD MACHINE TOOL COMPANY, SHOWING CHANGE-GEAR BOX.

in that position. The small vertical slot guide and the locking attachment ensure the proper mesh and no interference with other gears.

This device, which is nothing more nor less than an adaptation of the idea of the cone pulley, is without criticism in the matter of simplicity, and as the gears are all of the same diametral pitch they must of necessity all work properly together. The large number of gears in the nest render quite a variety of speeds possible and with sufficiently gradual increments as to meet all possible requirements of ordinary lathe practice. A possible criticism is that the large slot in the front side of the case would admit dust and dirt in perhaps objectionable quantities. But as a device of its type, requiring cessation of transmission of power while changing speed, it has a great deal to commend it, both as to ease of change and to excellence of design in general.

The Springfield Machine Tool Co., Springfield, Ohio, have applied a similar but less effective device to the feeds of their lathes, consisting substantially of an attachment whereby the "change gears," as ordinarily used on lathes for varying feed

speed of 75 ft. per minute at full load and 100 ft. per minute at no load; the bridge is equipped with a 45 h. p. motor giving a full load speed of 150 ft. and no load speed of 200 ft per minute.

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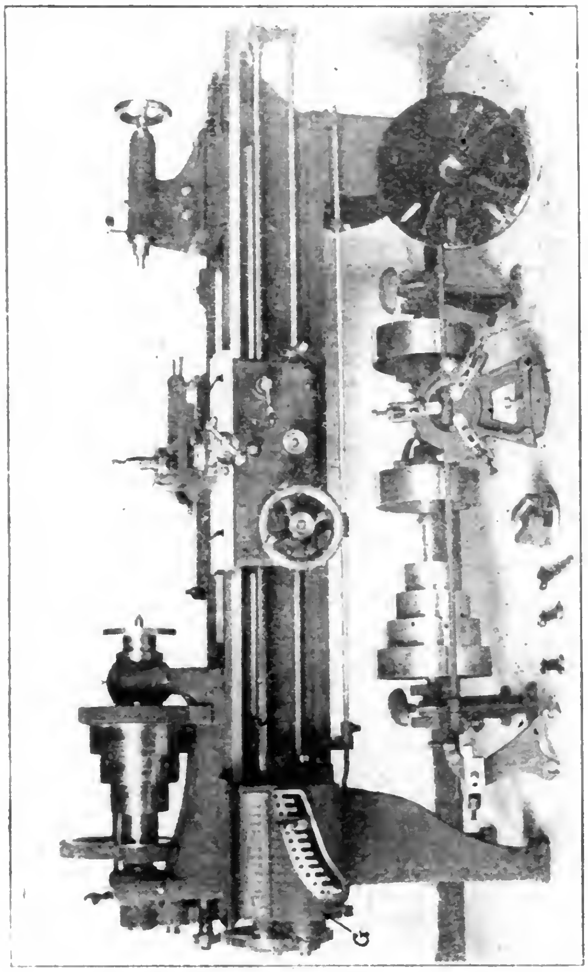

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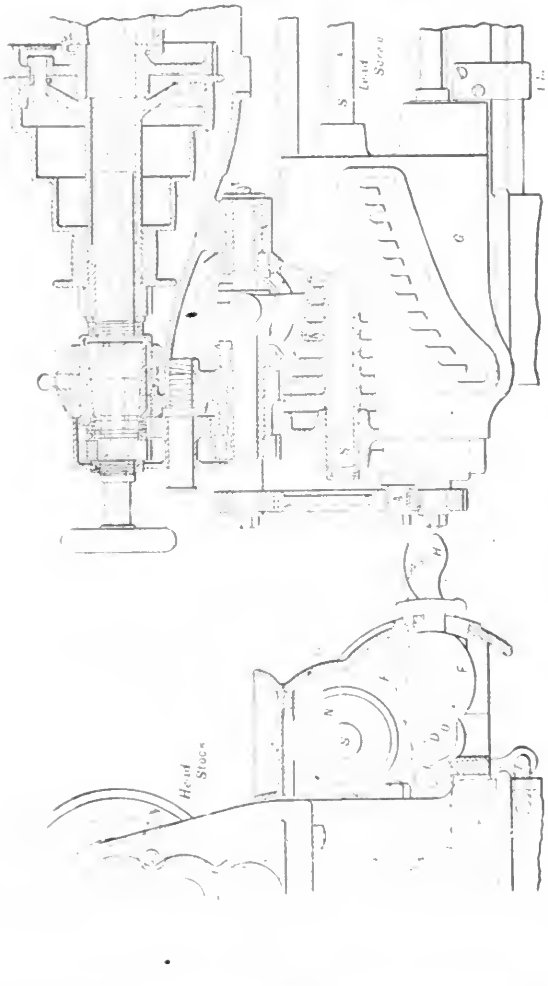

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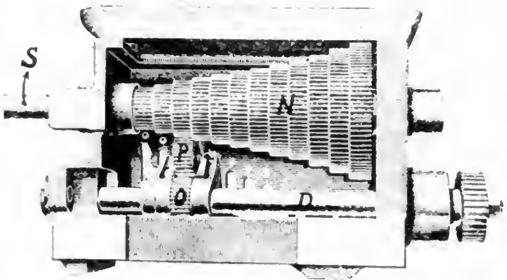

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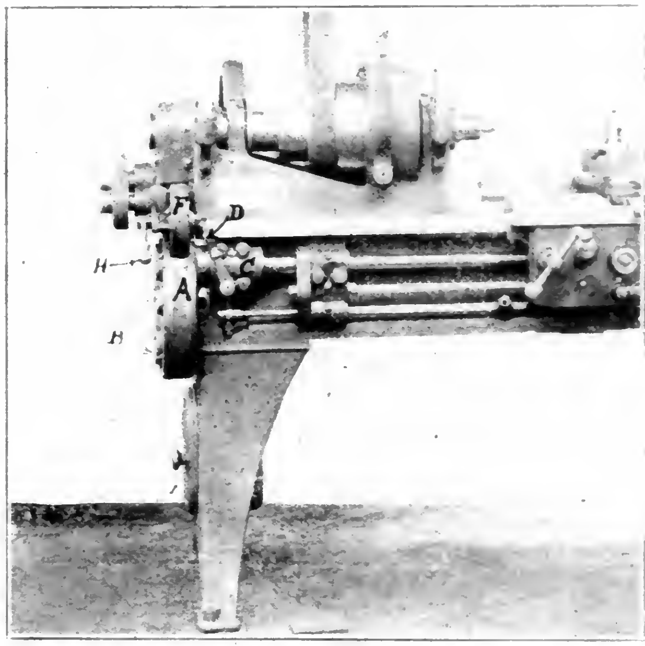

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in that position. The small vertical slot guide and the locking attachment ensure the proper mesh and no interference with other gears.

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The Springfield Machine Tool Co., Springfield, Ohio, have applied a similar but less effective device to the feeds of their lathes, consisting substantially of an attachment whereby the "change gears," as ordinarily used on lathes for varying feed

ratios, may be changed very quickly and in a simple manner. It consists of a gear box in which all the change gears are mounted, and means whereby the gear box may be readily adjusted so as to bring any one of the gears desired into connection with the lead screw. The gear case, which is shown at A, Figs. 4, 5 and 6, is a cast-iron box, the cover of which is capable of rotating about a stud, S, Figs. 5 and 6, at its center, and upon the inner side of which cover the change gears are permanently mounted. These gears have extension hubs which are fitted as journals into bearings in the cover to allow of rotation of the gears, and are held in position in their bearings by the collars, B, secured on their hubs outside of the cover. The holes shown in the protruding extension hubs at B, Fig. 5, are simply holes passing through the gear hubs for the clutching device. These bearings in the cover are arranged on a circle concentric with the stud, S, which circle is in line with the center of the lead screw, so that any of the gears may be placed

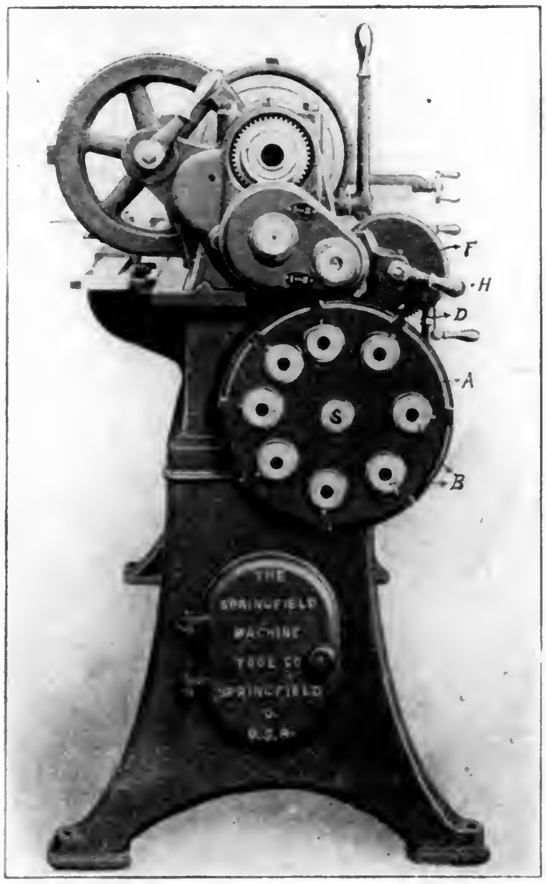
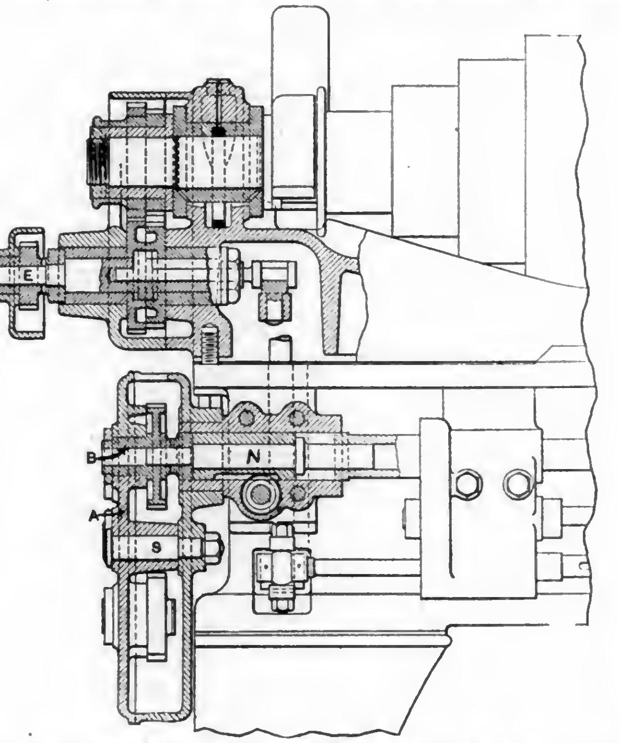


FIG. 5.—END VIEW OF IDEAL LATHE SHOWING METHOD OF SUPPORTING CHANGE GEARS BY THEIR HUBS.

opposite the end of the lead screw by simply revolving the gear case cover. For connecting any change gear to the lead screw, a clutching device, C, Fig. 4, is provided, which consists of a telescopically arranged extension of the lead screw shaft. This extension, N, Fig. 6, which is moved by lever D, is reduced at its end to enter the hole in the change gear, a distance equal to its width, before the clutches with which the change gears and the extension are fitted, engage with each other, so that when one of the change gears is connected with the lead screw, it ceases to depend on the gear case cover for support, but is substantially mounted on the lead screw. To connect one of these gears upon the lead screw it is simply necessary to bring that gear into position by revolving the gear case until the hole in its nub comes in line with the lead screw as shown by an indicator on the case, and then throw the clutch handle, D.

By the mounting of the change gears upon the inside of the gear case an effective guard is provided to protect the gears from dirt or injury, all of the eight gears being entirely concealed by the case except at the top where the intermediate gear, F, Figs. 4 and 5, enters to mesh with them. Thus this device has in this respect advantages over the former one, but, on the other hand it is, in reality, a retrogression from the ideal transmitter as compared with the Hendey-Norton gear box. The changes cannot be made nearly as quickly and they



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He is a graduate of the Sheffield Scientific School of Yale University, class of 1886, and entered the employ of this road in October of that year as a special apprentice, his time in this service being reduced because of previous experience in machine shops at Detroit. July 1, 1889, he was sent out as assistant road foreman of engines of the Philadelphia division, where his executive work began. He was transferred to a similar position on the Pittsburg division and afterward went to the P. W. & B. R. R. in the same capacity. In 1892 he went to the Pennsylvania Lines as assistant engineer of motive power and became master mechanic at Fort Wayne in 1893. October 26, 1896, he received the appointment of superintendent of motive power of the Pennsylvania Railroad division and upon the resignation of Mr. Casanave, became general superintendent of motive power of the lines east of Pittsburg, October, 1901. In 17 years he has risen from apprenticeship to the position of general manager. This record, his experience and ability, will unquestionably place him much higher in the councils of this great railroad.

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This lathe is designed to take very heavy cuts, using the new highly-efficient, self-hardening steel for tools, the capacity of the machine with respect to the size of the work being tires on driving-wheels ranging from 52 to 68 inches in diameter on tread. The face-plates are 72 inches in diameter and are driven through internal cut-gears of gun iron with which they are fitted, the gears having 100 teeth of 2-in. pitch and 7-in. face. A novel feature is introduced in that openings are provided in the face-plates, as shown in the left plate, for the purpose of receiving the crank-pins of the driving-wheels, permitting mounting the wheels close up to the face-plates, which greatly simplifies the method of driving them and largely reduces the strains resulting from the drive. The main spindles of the machine are of high-grade gun-iron, with front or main bearings 13 ins. diameter by 16 ins. long and rear bearings 10 ins. diameter by 14 ins. long, these bearings being bronze boxes of the usual construction permitting of adjustment for wear. The internal sliding spindles carrying the centers are 7 ins. in diameter, being made from steel forgings.

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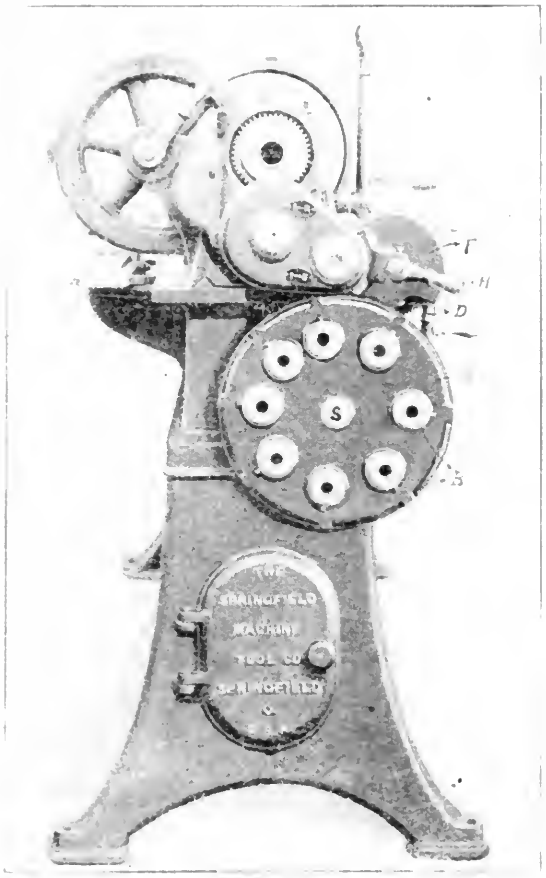

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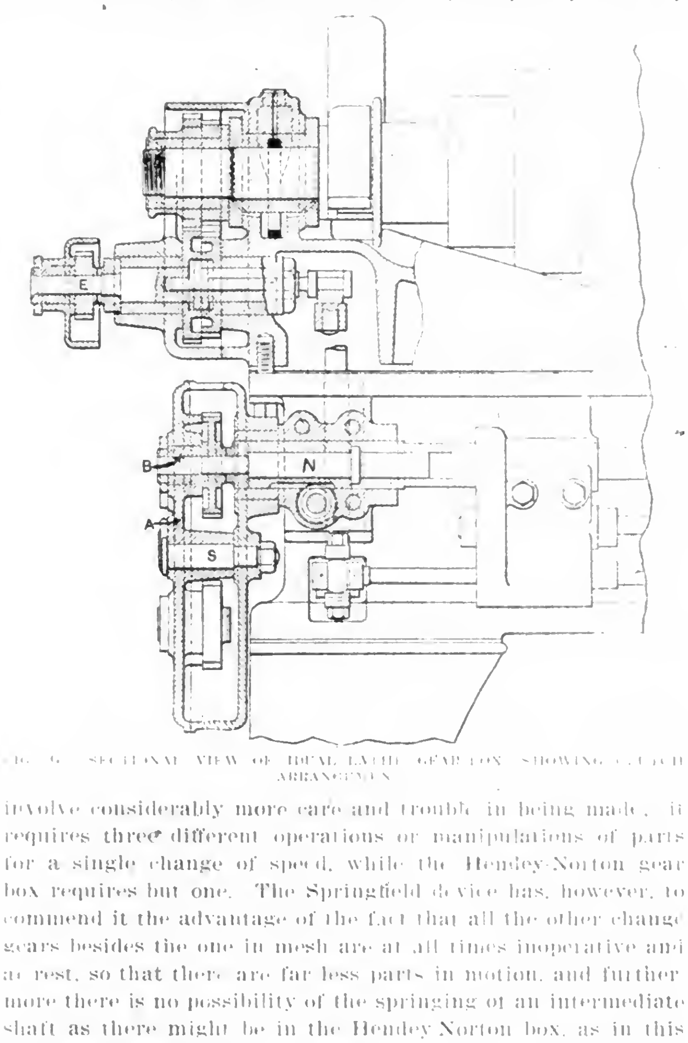

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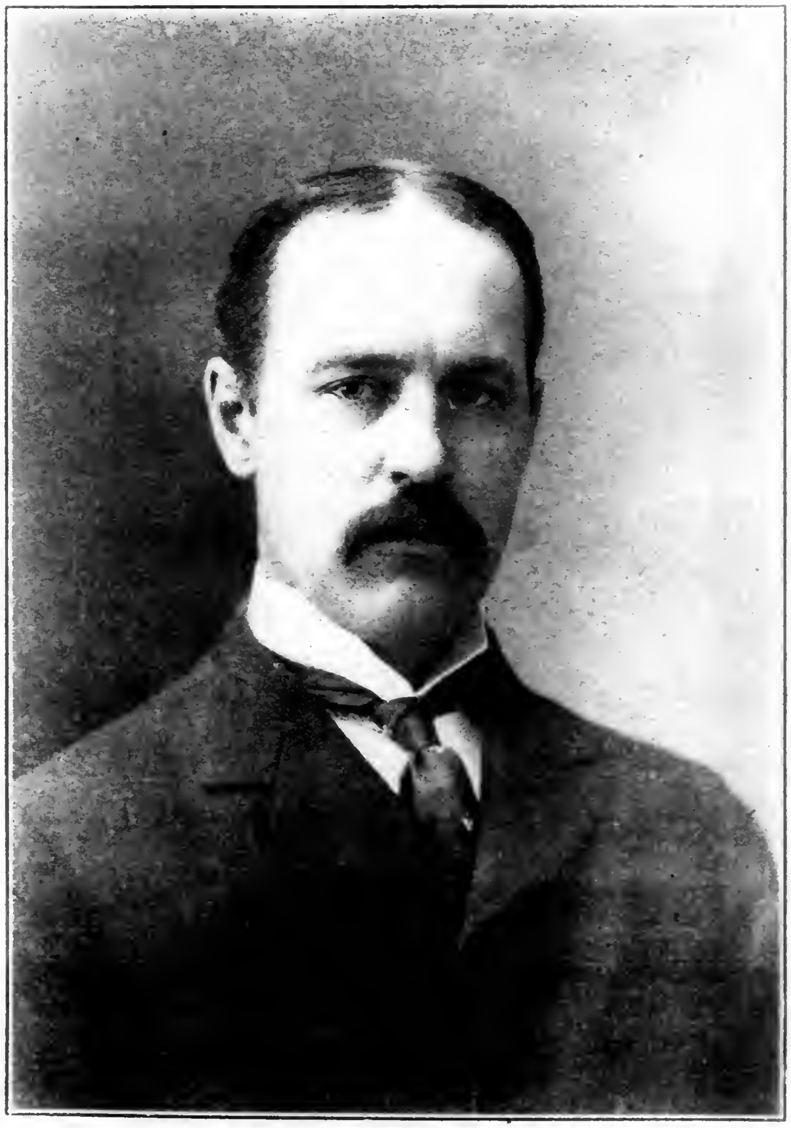

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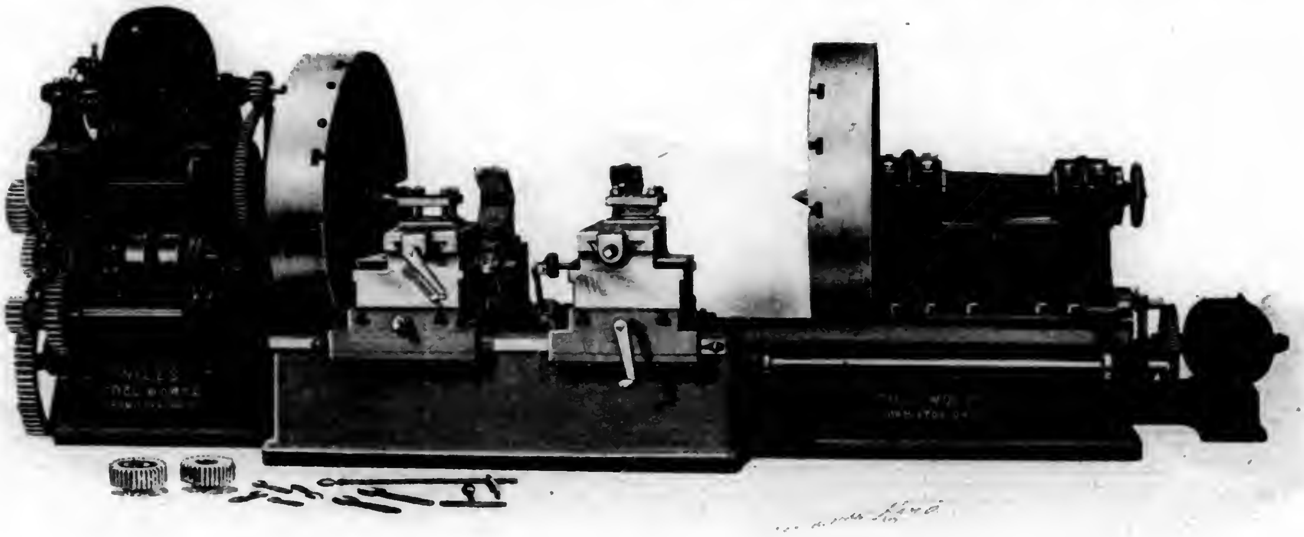
The carriages and tool-rests for this lathe are of great

strength and massiveness of construction. The tool-rests are provided with lateral adjustments on the carriages and also the necessary swivelling adjustment for turning the tapers on the treads of the tires. Two tools are at present being worked in each tool-rest by means of specially arranged tool-post fittings, which causes each two tools to act as a gang. The feeds for the tool-rests are driven by ratchets operated through the rocker arm and shaft shown at the right-hand front corner of the bed, the rocker arm being driven positively by one of the driving shafts at the rear of the bed. The lathe as equipped is intended for turning tires only, but by slight modifications it may be adapted for turning journals also. Also quartering attachments may be applied to both heads of this machine, although they can work simultaneously only on pairs of wheels having left-hand lead, but the smallest radius for which this lathe can be set for quartering is 13 ins. on account of the large size of spindle.

All of the gear-carrying shafts between the main motor and the face-plates run in bronze bearings, and all of the gears are of close grain gun-iron and the pinions of steel forgings, all having cut-gear teeth. The gearing and shafts are all designed to safely withstand a pressure transmitted which will bring a pressure of 18,000 lbs. at each tool post—this is probably about as heavy a pressure as our best tool steels of today will withstand when worked according to modern practice. Such a capacity as this is a revelation to the wheel-lathe practice and the possibilities which are open to it for rapid production are difficult to predict.



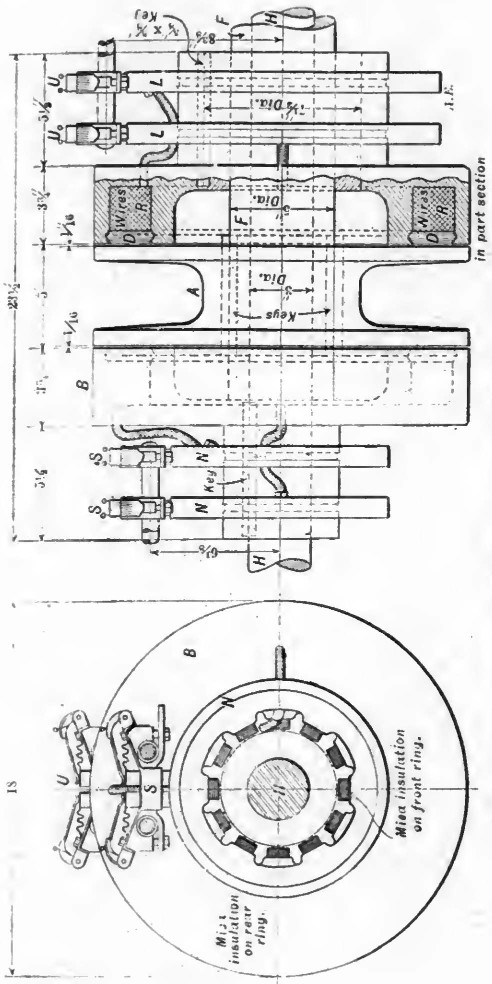
HEAVY NILES DRIVING-WHEEL LATHE, ELECTRICALLY DRIVEN THROUGH A TWO-SPEED MAGNETIC CLUTCH. INSTALLED AT THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

The main drive of this lathe is from the 25 h.-p. variable-speed, direct-current motor shown mounted above the main headstock of the lathe. This motor, which has a range of speed from 600 to 840 rev. per min. by field regulation, drives through trains of gears and a magnetic clutch by means of which, together with the change gears which are provided for the gear trains, a range of cutting speeds is available, varying from 10 to 30 ft. per min. on any diameter of tire within the capacity of the machine, and also a special extremely slow speed of from 4 to 6 ins. per min. The extremely slow speed is desirable for use when cutting through the hard spots that are so frequently met in turning steel tires, and it was for this purpose that the magnetic clutch device was applied. The other motor at the rear is a 3 h.-p. motor for use in adjusting the position of the right-hand headstock.

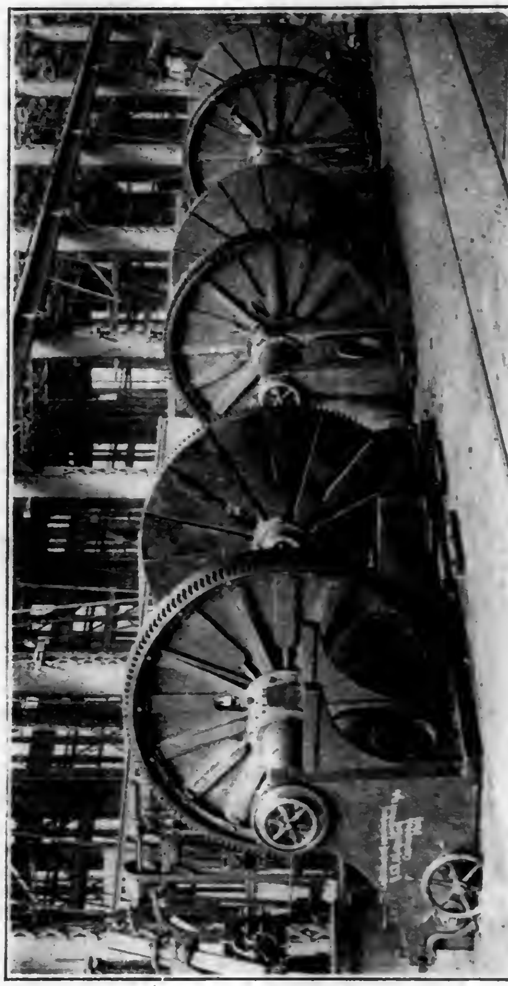
The magnetic clutch as here applied is of particular interest, as it is utilized for changing to an extremely great reduction of speed rather than for reversal of motion, its usual application heretofore. The form of clutch used is the iron-clad annular magnet type of magnetic clutch which was originated by the General Electric Co. for reversing planers in connection with positive motor driving. The accompanying diagram shows its construction. The two annular clutch magnets are shown at B and D, D being shown in part section to indicate the arrangement of the exciting coil, and between them is the common armature, or "keeper," A, upon which either may act. The magnets consist merely of 18-in. steel discs with grooves milled in their inner faces, which grooves are each filled with a coil of magnet wire, as shown at R-R; the coils are held in position by rings of lead, D-D, poured in while molten and calked in place, the heavy insulation of each coil preventing injury to it. The terminals of each coil are carried out through the rear of the disc to two collector rings, L-L, and N-N, mounted on extended hubs, and into these the current for either coil is fed by the carbon brushes, S-S and U-U.

When current is thrown into either magnet, it draws the armature, A, up against it and causes the armature, by the friction due to the pressure of the contact, to revolve with it. The armature, A, is keyed directly to the hollow shaft, F, which drives the main shaft and through gearing the two face-plates of the lathe. Clutch, B, is keyed directly to the inner shaft H, which is driven from the motor for the higher speeds, and clutch, D, is driven through a special spiral gear on its hub for the extreme low speed, both clutches revolving in the same direction. Each clutch when in action requires only $1\frac{1}{2}$ ampere of current at a voltage of 110 volts, and has a capacity of transmitting 18-brake horse-power at 142 rev. per min.

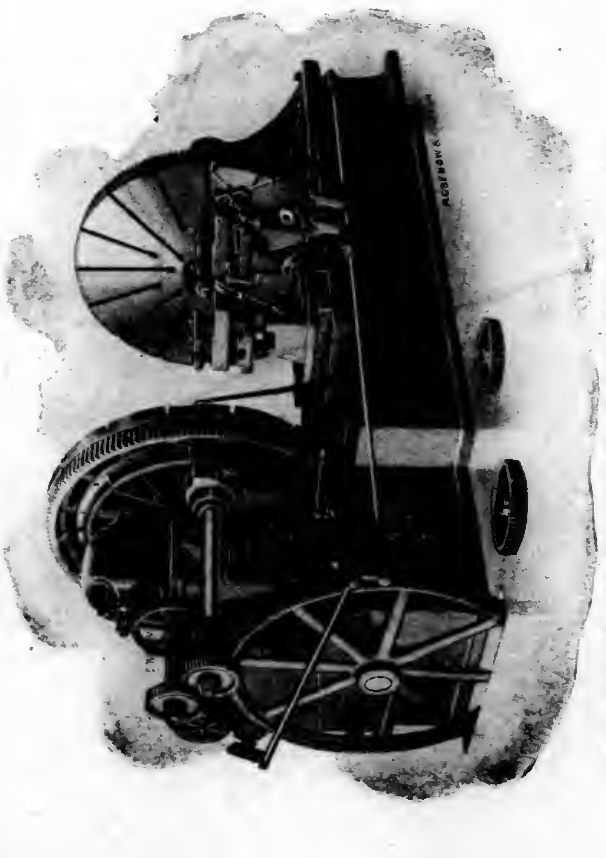
Thus when clutch, B, is thrown into action the face-plates are driven at the usual cutting speeds of from 10 to 30 ft. per min., as required, but when B is thrown out and clutch, D, thrown in, the slow speed of 4 to 6 ins. per min. is started up. The change from one to the other may be made instantaneously by merely throwing a switch from one contact to another. A great advantage of the application of this magnetic clutch—one which has largely been lost sight of—is the fact that it offers to the positive motor drive all the advantages of belt driving that have been lost through the use of gearing; the possibility of slipping when the tool is badly overloaded, which acts as a protection to the motor and which so characterizes belt drives, is an advantage of considerable



DETAILS OF THE TWO-SPEED MAGNETIC CLUTCH USED ON THE ALTOONA LATHE: DESIGNED BY THE GENERAL ELECTRIC COMPANY.



THE THREE 84-INCH NILES DRIVING-WHEEL LATHES INSTALLED IN THE COLLINWOOD SHOPS OF THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



HEAVY 90-INCH NILES DRIVING-WHEEL LATHE INSTALLED AT THE BLOOMINGTON SHOPS OF THE CHICAGO & ALTON RAILWAY.

value in the magnetic clutch. The magnetic clutch, as well as the two motors used upon this lathe, were furnished by the General Electric Co., Schenectady, N. Y.

The engraving at the left is a view of a very heavy 90-in. driving-wheel lathe, which the Niles Tool Works has recently installed at the Bloomington shops of the Chicago & Alton Railway, and of which type and size they have lately supplied two machines to the Chicago & Northwestern for their West Chicago shops. The view above on this page shows the three 84-in. driving-wheel lathes that have been installed at the new Collinwood shops of the Lake Shore & Michigan Southern Railway by the Niles Co., each of which is direct driven by a 12-speed Crocker-Wheeler motor of 15 h.-p. operating on the direct-current multiple-voltage system.

These lathes are all arranged so that the face-plates may be driven together, or separately, as desired, each head having a clutch for disconnecting its driving gear. The right-hand heads are arranged for six speeds, while the left-hand heads have 12 speeds, six of which are rapid for boring work. Each face-plate is detachable for replacing in case of breakage. The main spindles are of cast iron, each having internal sliding spindles capable of extending sufficiently to support the wheels with crank-pins in place.

The tool-rests have power feeds at all angles and in two directions when once set. The bed is made high in front to permit of short tool posts of great strength and stiffness for withstanding the stress of heavy cutting, while the rear is made low to facilitate rolling in the wheels. The right-hand heads in these machines, as well as the carriages, are traversed by hand power. These machines are also adapted for the use of quartering attachments on either face-plate, the boring spindles for which are held by face-plate guides close up to the work.

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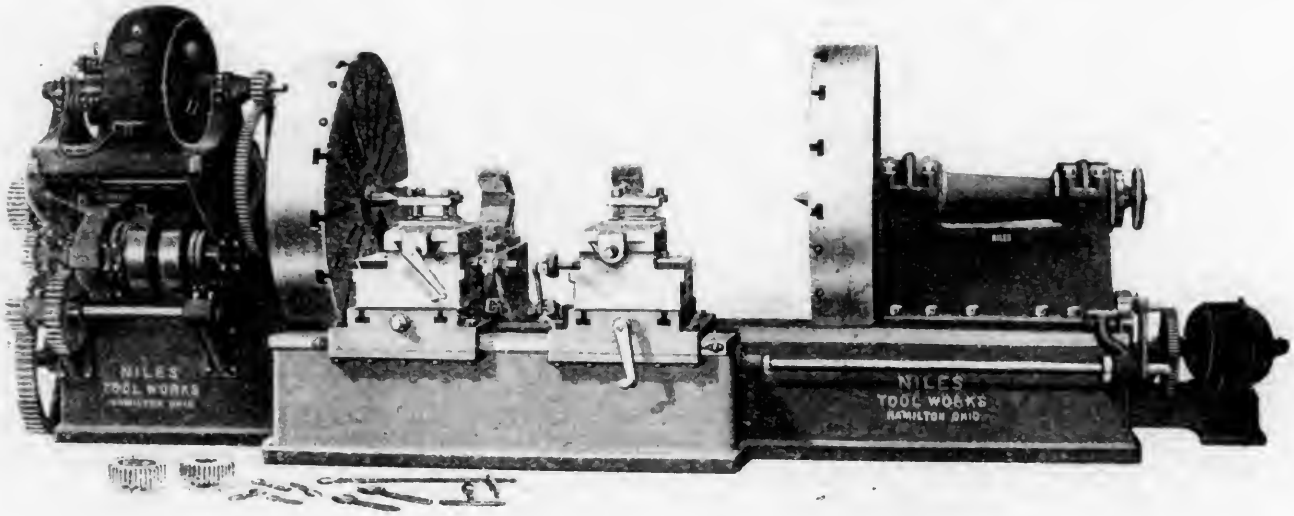

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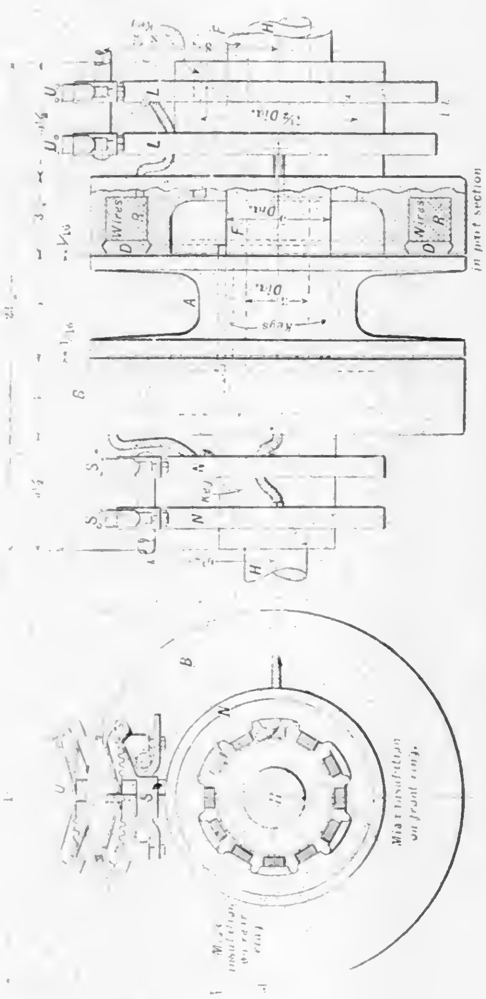
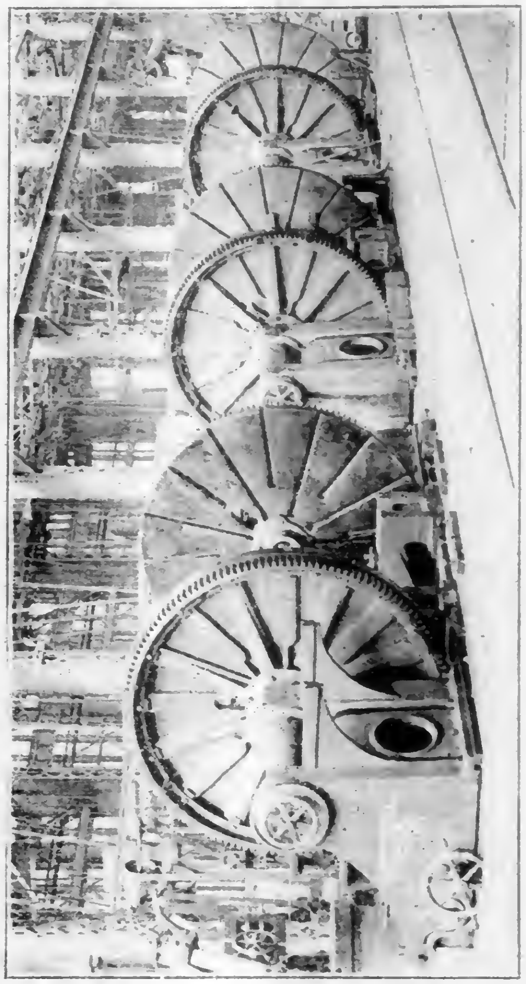
Thus when clutch, B, is thrown into action the face-plates are driven at the usual cutting speeds of from 10 to 30 ft. per min., as required, but when B is thrown out and clutch, D, thrown in, the slow speed of 1 to 6 ins. per min. is started up. The change from one to the other may be made instantaneously by merely throwing a switch from one contact to another. A great advantage of the application of this magnetic clutch—one which has largely been lost sight of—is the fact that it offers to the positive motor drive all the advantages of belt driving that have been lost through the use of gearing; the possibility of slipping when the tool is badly overloaded, which acts as a protection to the motor and which so characterizes belt drives, is an advantage of considerable



DETAILS OF THE TWO-SPEED MAGNETIC CLUTCH USED ON THE MAHOGANY LATHE DESIGNED BY THE GENERAL ELECTRIC COMPANY.

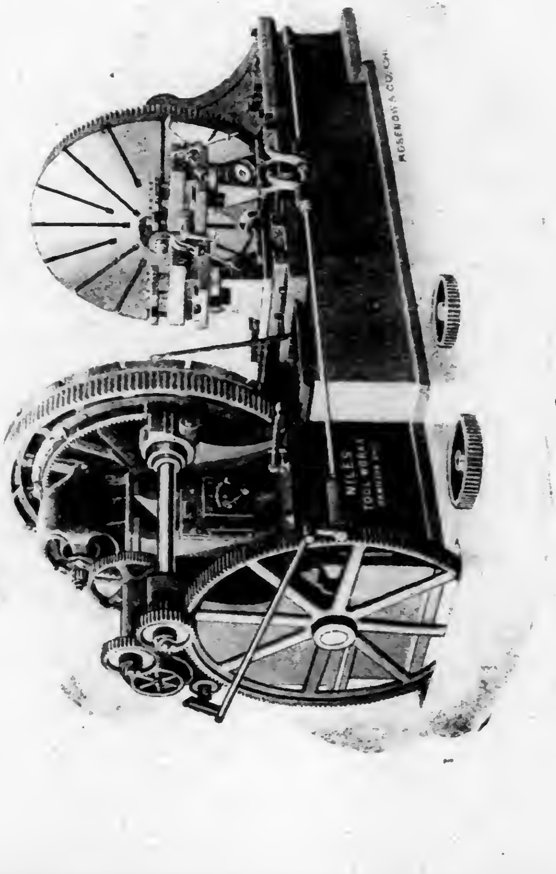


value in the magnetic clutch. The magnetic clutch, as well as the two motors used upon this lathe, were furnished by the General Electric Co., Schenectady, N. Y.

The engraving at the left is a view of a very heavy 90-in. driving-wheel lathe, which the Niles Tool Works has recently installed at the Bloomington shops of the Chicago & Alton Railway, and of which type and size they have lately supplied two machines to the Chicago & Northwestern for their West Chicago shops. The view above on this page shows the three 84-in. driving-wheel lathes that have been installed at the new Collinwood shops of the Lake Shore & Michigan Southern Railway by the Niles Co., each of which is direct driven by a 12-speed Crocker-Wheeler motor of 15 h. p. operating on the direct-current multiple voltage system.

These lathes are all arranged so that the face-plates may be driven together or separately, as desired, each head having a clutch for disconnecting its driving gear. The right hand heads are arranged for six speeds, while the left hand heads have 12 speeds, six of which are rapid for boring work. Each face-plate is detachable for replacing in case of breakage. The main spindles are of cast iron, each having internal sliding spindles capable of extending sufficiently to support the wheels with crank pins in place.

The tool-rests have power feeds at all angles and in two directions when once set. The bed is made high in front to permit of short tool posts of great strength and stiffness for withstanding the stress of heavy cutting, while the rear is made low to facilitate rolling in the wheels. The right hand heads in these machines, as well as the carriages, are traversed by hand power. These machines are also adapted for the use of quartering attachments on either face-plate, the boring spindles for which are held by face-plate guides close up to the work.



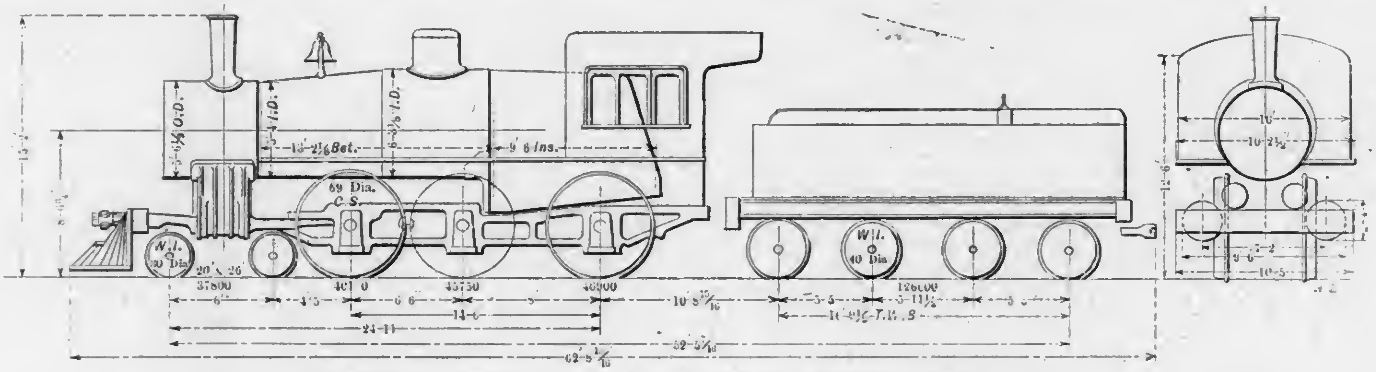
HEAVY 90-INCH NILES DRIVING WHEEL LATHE INSTALLED AT THE BLOOMINGTON SHOPS OF THE CHICAGO & ALTON RAILWAY.

CANADIAN PACIFIC PASSENGER LOCOMOTIVES.

4—6—0 TYPE.

BUILT BY THE CANADIAN PACIFIC RAILWAY.

This new design of locomotive for the Canadian Pacific is of special interest because it represents the ideas of Mr. E. A. Williams, superintendent of rolling stock of this road, and Mr. A. W. Horsey, chief draftsman; also because six of them are to be built by Nelson, Reid & Co., of Glasgow, Scotland, in addition to twelve which are being completed at the Delorimer avenue shops of the road in Montreal. The first of them was built last August, and at present six are running and giving excellent results. It is impossible at this time to present more than the diagram showing the general proportions of the engine.



PASSENGER LOCOMOTIVE. 4—6—0 TYPE.—CANADIAN PACIFIC RAILWAY.

These engines have piston valves with inside steam admission and outside exhaust, with steam ports made as direct as possible. Special care was taken in designing the valve gear, to get it straight and direct, with little opportunity for springing or lost motion to distort or restrict the steam distribution. The piston valves are in line with the centers of the frames and there is no motion bar. A rocker is used, journaled on a pin secured to the frame, the valve stem being long and perfectly straight. Both rocker arms are inside the frames. The driving-spring rigging is underhung and is made central with the driving journals. In keeping down to a maximum of 46,000 lbs. per pair of wheels it was necessary to slope the back boiler head, and this gives a roomy cab. For a number of years this road has used cabs of steel with rounded corners. This and the "turtle-back" tenders give the engine an attractive appearance. Ten-inch steel channels were used in the construction of the tender frame, and it is very strong. These are handsome engines. This road gives special attention to attractive outline and good appearance of its locomotives. We hope to illustrate the valve motion in a later issue.

CANADIAN PACIFIC RAILWAY.

4—6—0 Type.

Passenger Locomotive.

Weight on drivers	126,750 lbs.
Total weight	164,500 lbs.
Cylinders	20 x 26 ins.
Driving wheels, diameter	69 ins.
Boiler	Radial stayed extended wagon top
Boiler pressure	210 lbs.
Tubes	336—2-in., 13 ft. 2 ins. long
Firebox	114 x 42 ins.
Heating surface, tubes	2,262 sq. ft
Heating surace, firebox	159 sq. ft.
Heating surface, total	2,421 sq. ft.
Grate area	332 sq. ft.
Driving journals	9 x 12 ins.
Engine truck journals	6 x 10 ins.
Tender journals	5½ x 10 ins.
Tender, water capacity	5,000 gals.
Tender, coal capacity	10 tons
Tender, weight empty	56,000 lbs.
Tender, weight loaded	126,600 lbs.

BETTER CAST IRON CAR WHEELS.

Speaking of improvements in car-wheel iron, Mr. C. V. Slocum, in a paper before the Pittsburgh Railway Club, said: "Our own experiments with the metal démonstrate that titanium in iron gives greater density to the metal, surprisingly increases transverse strength and gives a harder chill or wearing quality in the wheel. This is no light statement when it is remembered that the tread, or wearing surface, of a car wheel is already harder than steel—in fact a rough section of chilled car-wheel iron will cut glass. The clearly demonstrated practicability of supplying in one casting a wheel with a hard tread for wear and a soft hub for machine work, with strength only limited by the price which the purchasing agent is willing to pay for it, makes the chilled cast-iron wheel stand forth as its own probable successor in carrying the heavy traffic of the future."

A rail 250 ft. long has been rolled at the Hoerde Works, Germany. It was exhibited at the Dusseldorf exhibition. One of the Krupp exhibits was a hollow bored shaft for a steamer forged in a single piece in a length of 148 ft. The core was lying beside it. The ingot from which this shaft was made required the contents of 1,768 crucibles and the pouring was performed in 30 minutes by 490 workmen. Crucible steel ingots up to 85 tons are cast at Essen and open-hearth steel ingots up to 120 tons.

It has been reported in Chicago that there is another project on foot for the development and utilization of the power made available by the flow of water from the Chicago Drainage Canal, which empties into the Des Plaines River above Joliet. A dam is to be located some distance below Joliet, the necessary options having been obtained upon the land lying along the river which would be overflowed.

A grill room chair car has been introduced into the Chicago & Alton passenger service between Chicago and Kansas City. Anything from a sandwich to a champagne supper is served from a small 8 by 10 ft. kitchen in one end of the car, the grill room being fitted up after the style of small American dining rooms with tables for six people.

Remarkably low steam consumption for Sulzer engines (Winterthur, Switzerland) is recorded in *Engineering News.* In tests conducted by Professors Weber and Schroeter the consumption was 8.97 and 9.41 lbs of steam per horse power hour superheated and 11.98 and 11.57 lbs. saturated. The power developed was about 3,000 horse power.

Interest in superheating, as applied to locomotives, is increasing in Continental Europe. The Prussian State Railways have placed an order for the equipment of twelve express, the same number of passenger and freight and fifteen freight locomotives with the Schmidt system of superheating.

REMARKABLE LOCOMOTIVE PERFORMANCE.

MICHIGAN CENTRAL RAILROAD.

Through the courtesy of Mr. E. D. Bronner, superintendent of motive power of the Michigan Central, the record of a recent very fast run with a heavy train on that road has been received. The engine was No. 483, of the 4—4—2 type built by the Schenectady Works of the American Locomotive Company and similar to those of the same type on the New York Central. The train of 16 passenger equipment cars weighed 605.55 tons and was hauled 168.22 miles in 127 minutes—at the rate of 55.8 miles per hour. There were eight slow-downs. Considering these and the weight of the train, this record is believed to be unsurpassed. The weight of the engine with a half tank of water and coal is 125.62 tons, making a total of 731.19 tons, including the engine and tender. The weight 605.57 tons is that back of the tender. This run demonstrates the value of this able boiler with 3,521 sq. ft. of heating surface, and of the large grate. The record of the run is as follows:

RECORD OF THE RUN.

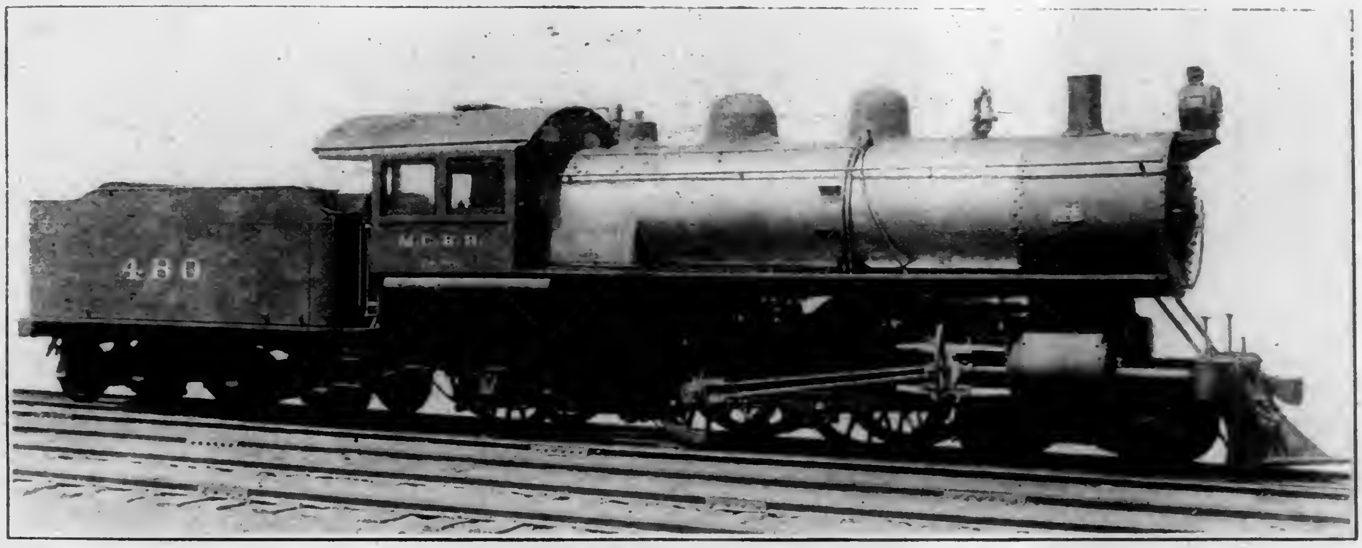
Station.	Time.	Mins.	Miles.	Miles per Hour.	
Bridgeburg.......A	8.13 A. M.				
Bridgeburg.......D	8.19 A. M.				
Victoria	8.21	2	0.81	24.30	Yard limits
Niagara Junction.	8.24	3	1.27	25.40	Yard limits
Stevensville	8.30	6	5.06	50.60	
Brookfield	8.35	5	5.44	65.28	
Welland	8.40	5	4.71	56.52	Slow down
Perry	8.50	10	9.34	56.04	Slow down
Attercliff	8.59	9	8.22	54.80	
Canfield	9.07	8	7.33	54.98	Slow down
Edward	9.12	5	4.82	57.84	
Hagersville	9.24	12	11.57	57.85	Slow down
Townsend	9.30	6	5.57	55.70	
Villa Nova	9.32	2	2.25	67.50	
Waterford	9.37	5	4.93	59.16	Slow down
Windham	9.44	7	6.57	56.31	
Pt. Dover Junc...	9.48	4	4.13	61.59	Slow down
Hawtrey	9.49½	1½	1.23	49.20	
Cornell	9.54½	5	5.08	60.96	
Tilsonburg	10.00	5½	5.44	59.35	
Brownsville	10.06	6	5.79	57.90	
Springfield	10.11½	5½	5.47	50.67	Slow down
Aylmer	10.14	2½	2.46	59.04	
Kingsmill	10.17	3	2.74	54.80	
Yarmouth Crossing					Slow down
St. Thomas .....A	10.26	9	7.99	53.27	Yard limits
		127	118.22		

The train consisted of eight New York Central coaches, one baggage and mail car, one express car, five Michigan Central coaches and one Pullman sleeper. The cars weighed 1,081,150 lbs. and the contents (estimated) 130,000 lbs. Such a train would require a tractive effort of about 13,000 lbs. at a speed of 55.8 miles per hour. This would call for a mean effective pressure of about 88 lbs. and the probable horse-power developed would be about 1,900 h.-p. In the absence of indicator cards these figures are estimated, and also the figures of 142 lbs. of coal per square foot of grate per hour with which this work is believed to have been done.

This photograph is of another engine of the same class as No. 483, the chief dimensions being as follows:

Michigan Central 4—4—2 Type Passenger Locomotive.

Weight in working order	176,000 lbs.
Weight on drivers	95,000 lbs.
Weight engine and tender in working order	280,000 lbs.
Wheel base, driving	7 ft.
Wheel base, total	27 ft. 3 ins.
Wheel base, total, engine and tender	52 ft. 10½ ins.
Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Kind of slide valves	Piston
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	⅛ in.
Lead of valves in full gear	Line and line
Diameter of driving wheels outside of tire	79 ins.
Thickness of tire	3½ ins.
Diameter and length of driving journals	9¼ ins. diameter x 12 ins.
Diameter and length of main crankpin journals	6½ ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals	7 ins. diameter x 4¼ and 5 x 3¾ ins.
Engine truck, journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	36 ins.
Boiler, outside diameter of first ring	72⅛ ins.
Boiler, pressure	200 lbs.
Firebox, length	96⅛ ins.
Firebox, width	75⅜ ins.
Firebox, depth	Front, 80¼ ins.; back, 69 ins.
Tubes, number	398
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,314.75 sq. ft.
Heating surface, water tubes	27.09 sq. ft.
Heating surface, firebox	180 sq. ft.
Heating surface, total	3,521.84 sq. ft.
Grate surface	50.3 sq. ft.
Exhaust nozzles	5¼—5½—5¾ diameter
Smokestack, inside diameter	14 ins.
Smokestack, top above rail	14 ft. 9 ins.



4—4—2 TYPE PASSENGER LOCOMOTIVE.—MICHIGAN CENTRAL RAILROAD.

BUILT BY THE AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS.

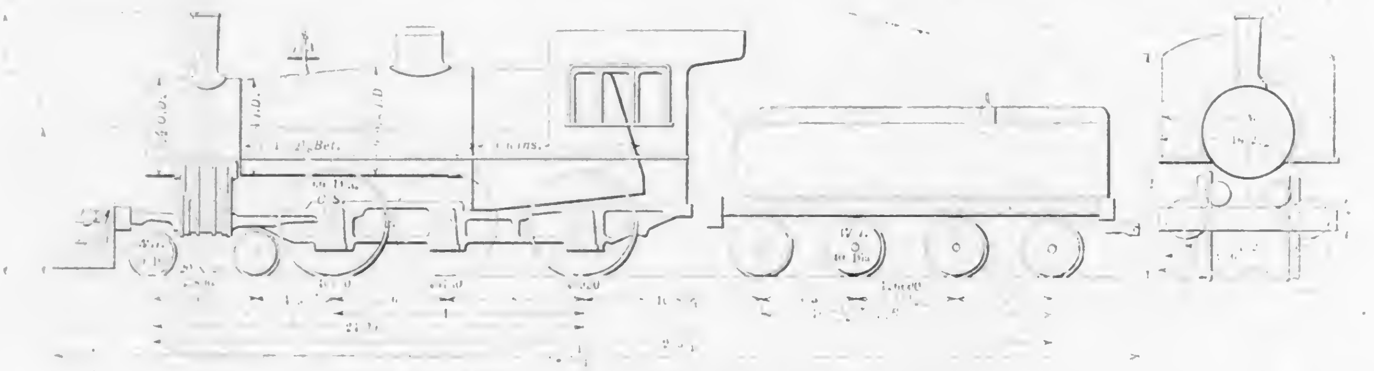
Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, has returned from a remarkably successful European trip. One of his purposes was to establish a new plant, which was accomplished. It will be located at Fraserburg, in Scotland, will cost $175,000, and will be equipped with American machinery. This is the third European factory for this concern. Mr. Duntley brought back with him orders for 2,500 pneumatic tools. Without doubt the number is large because of the campaign of education which the company has been carrying on in Europe through skilled American mechanics, sent over to demonstrate the value of these tools. The company has made several changes among its representatives in the United States. Mr. George A. Barden has been transferred from Buffalo to Philadelphia, Mr. C. R. Green has been transferred from Cleveland to Buffalo, and Mr. Charles Parsons looks after the Northwest section.

CANADIAN PACIFIC PASSENGER LOCOMOTIVES.

4—6—0 Type.

BUILT BY THE CANADIAN PACIFIC RAILWAY.

This new design of locomotive for the Canadian Pacific is of special interest because it represents the ideas of Mr. R. A. Williams, superintendent of rolling stock of this road, and Mr. A. W. Horsey, chief draftsman, also because six of them are to be built by Nelson, Reid & Co., of Glasgow, Scotland, in addition to twelve which are being completed at the Delorimier avenue shops of the road in Montreal. The first engine was built last August, and at present six are running and giving excellent results. It is impossible at this time to present more than the diagram showing the general proportions of the engine.



PASSENGER LOCOMOTIVE—4-6-0 TYPE—CANADIAN PACIFIC RAILWAY.

These engines have piston valves with inside steam admission and outside exhaust, with steam ports made as direct as possible. Special care was taken in designing the valve gear to get it straight and direct, with little opportunity for springing or lost motion to distort or restrict the steam distribution. The piston valves are in line with the centers of the frames and there is no motion bar. A rocker is used, supported on a pin secured to the frame, the valve stem being short and perfectly straight. Both rocker arms are inside the frames. The driving-spring rigging is underhung and is made central with the driving journals. In keeping down to a maximum of 16,000 lbs. per pair of wheels it was necessary to slope the back boiler head, and this gives a roomy cab. For a number of years this road has used cabs of steel with rounded corners. This and the "turtle-back" tenders give the engine an attractive appearance. Ten-inch steel channels are used in the construction of the tender frame, and it is very strong. These are handsome engines. This road gives special attention to attractive outline and good appearance of its locomotives. We hope to illustrate the valve motion in a later issue.

CANADIAN PACIFIC RAILWAY.

4-6-0 Type.

Passenger Locomotive.

Weight on drivers	126,750 lbs.
Weight, total	164,500 lbs.
Cylinders	20 x 26 ins.
Diameter of drivers	69 ins.
Boiler	Radial stayed extended wagon top
Steam pressure	210 lbs.
Tubes	326 2-in., 13 ft. 2 ins. long
Firebox	114 x 42 ins.
Heating surface, tubes	2,262 sq. ft.
Heating surface, firebox	159 sq. ft.
Heating surface, total	2,421 sq. ft.
Grate area	32 sq. ft.
Driving journals	9 x 12 ins.
Engine truck journals	6 x 10 ins.
Tender journals	5½ x 10 ins.
Tender water capacity	5,000 gals.
Tender coal capacity	10 tons.
Tender weight empty	56,000 lbs.
Tender weight loaded	126,600 lbs.

BETTER CAST IRON CAR WHEELS.

Speaking of improvements in car-wheel iron, Mr. C. V. Slocum, in a paper before the Pittsburgh Railway Club, said: "Our own experiments with the metal demonstrate that titanium in iron gives greater density to the metal, surprisingly increases transverse strength and gives a harder chill or wearing quality in the wheel. This is no light statement when it is remembered that the tread, or wearing surface, of a car wheel is already harder than steel—in fact a rough section of chilled car-wheel iron will cut glass. The clearly demonstrated practicability of supplying in one casting a wheel with a hard tread for wear and a soft hub for machine work, with strength only limited by the price which the purchasing agent is willing to pay for it, makes the chilled cast-iron wheel stand forth as its own probable successor in carrying the heavy traffic of the future."

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REMARKABLE LOCOMOTIVE PERFORMANCE.

MICHIGAN CENTRAL RAILROAD.

Through the courtesy of Mr. E. D. Bronner, superintendent of motive power of the Michigan Central, the record of a recent very fast run with a heavy train on that road has been received. The engine was No. 183, of the 4—4—2 type built by the Schenectady Works of the American Locomotive Company and similar to those of the same type on the New York Central. The train of 16 passenger equipment cars weighed 605.55 tons and was hauled 168.22 miles in 127 minutes at the rate of 55.8 miles per hour. There were eight slow downs. Considering these and the weight of the train, this record is believed to be unsurpassed. The weight of the engine with a half tank of water and coal is 125.62 tons, making a total of 731.19 tons, including the engine and tender. The weight 605.57 tons is that back of the tender. This run demonstrates the value of this able boiler with 3,521 sq. ft. of heating surface, and of the large grate. The record of the run is as follows:

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Station	Time.	Mins.	Miles.	Miles per Hour	
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Hawtrey	9.49½	1½	1.23	49.20	
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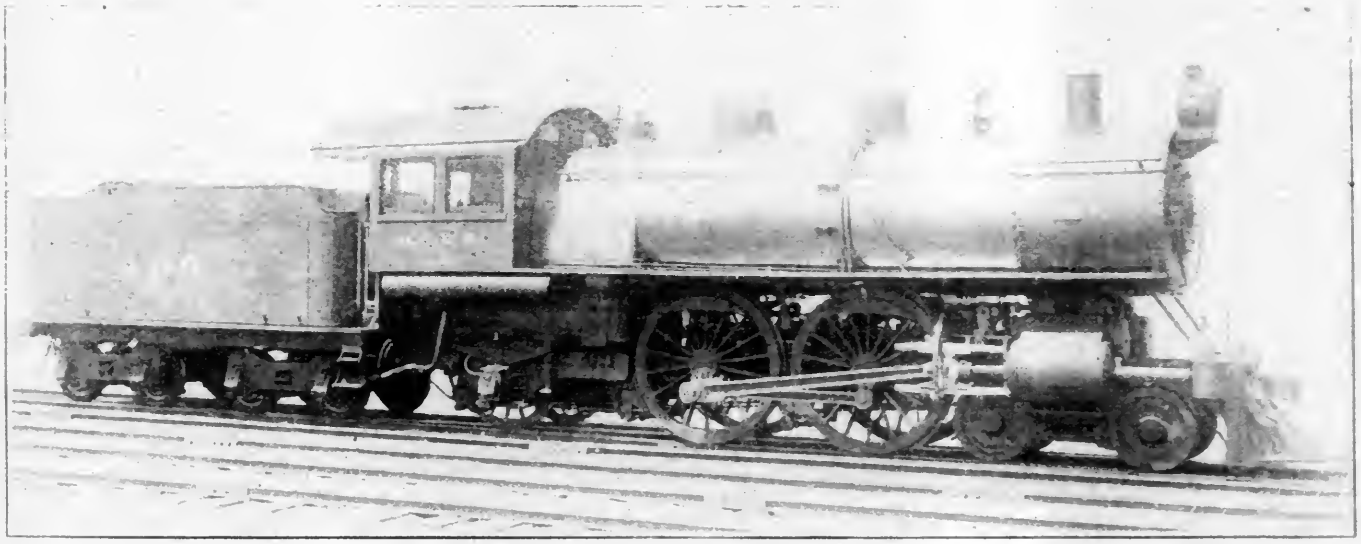
The train consisted of eight New York Central coaches, one baggage and mail car, one express car, five Michigan Central coaches and one Pullman sleeper. The cars weighed 1,081,150 lbs. and the contents (estimated) 130,000 lbs. Such a train would require a tractive effort of about 13,000 lbs. at a speed of 55.8 miles per hour. This would call for a mean effective pressure of about 88 lbs. and the probable horse-power developed would be about 1,900 h.-p. In the absence of indicator cards these figures are estimated, and also the figures of 112 lbs. of coal per square foot of grate per hour with which this work is believed to have been done.

This photograph is of another engine of the same class as No. 183, the chief dimensions being as follows:

Michigan Central 4—4—2 Type Passenger Locomotive.

Weight in working order	17[illegible]
Weight on drivers	[illegible]
Weight engine and tender in working order	[illegible]
Wheel base, driving	[illegible]
Wheel base, total	[illegible]
Wheel base, total, engine and tender	[illegible]
Diameter of cylinder	[illegible]
Stroke of piston	[illegible]
Kind of slide valve	[illegible]
Greatest travel of slide valves	[illegible]
Outside lap of slide valves	[illegible]
Inside clearance of slide valves	[illegible]
Lead of valves in full gear	[illegible]
Diameter of driving wheel outside of tire	[illegible]
Thickness of tire	3[illegible]
Diameter and length of driving journals	9½ ins. diameter x [illegible]
Diameter and length of main crankpin journals	6½ ins. diameter x [illegible]
Diameter and length of side-rod crankpin journals	7 ins. diameter x 4¼ and 5 x 3¾
Engine truck, journals	6 ins. diameter x [illegible]
Diameter of engine truck wheels	[illegible]
Boiler, outside diameter of first ring	72[illegible]
Boiler, pressure	200 lbs.
Firebox, length	[illegible]
Firebox, width	[illegible]
Firebox, depth	Front, 80¼ ins. [illegible]
Tubes, number	[illegible]
Tubes, diameter	[illegible]
Tubes, length over tube sheets	[illegible]
Fire brick, supported on	Water tubes
Heating surface tubes	[illegible] sq. ft.
Heating surface, water tubes	27[illegible] sq. ft.
Heating surface, firebox	180[illegible] sq. ft.
Heating surface, total	[illegible]21.84 sq. ft.
Grate surface	50[illegible] sq. ft.
Exhaust nozzles	5¼, 5½, 5¾ diameter
Smokestack, inside diameter	[illegible]
Smokestack, top above rail	[illegible]



4—4—2 TYPE PASSENGER LOCOMOTIVE—MICHIGAN CENTRAL RAILROAD.

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Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, has returned from a remarkably successful European trip. One of his purposes was to establish a new plant, which was accomplished. It will be located at Fraserburg, in Scotland, will cost $175,000, and will be equipped with American machinery. This is the third European factory for this concern. Mr. Duntley brought back with him orders for 2,500 pneumatic tools. Without doubt the number is large because of the campaign of education which the company has been carrying on in Europe through skilled American mechanics, sent over to demonstrate the value of these tools. The company has made several changes among its representatives in the United States. Mr. George A. Barden has been transferred from Buffalo to Philadelphia. Mr. C. R. Green has been transferred from Cleveland to Buffalo, and Mr. Charles Parsons looks after the Northwest section.

PHENOMENAL MILLING MACHINE WORK.

Among some machine tools recently purchased for use in railroad shops, we notice a large number of milling machines made by the Cincinnati Milling Machine Company, Cincinnati, Ohio. Their plain miller, having a table of 16 ins. wide with 42 ins. travel, has several points of particular advantage for railroad shops. One of the strong features in its design, which has attracted a great deal of attention and won the approbation of master mechanics generally, is the method of driving the feed; instead of driving the feed screws by a belt and cone pulleys from the spindle, a train of gears is used, making an entirely positive drive, so that the relation between the revolutions of the cutter and the feed of the work to the cutter is always positive. This feed mechanism is so designed as to be the strongest part of the machine; all the gears are drop-forged steel with cut teeth, and hence, as there is no slippage possible between the main spindle and the feed screws, the operator can depend upon the work being fed to the cutter as long as the machine continues in operation.

Another feature of this mechanism is that the rate of feed can be changed in an instant at any time no matter how fast the spindle is turning or how heavy a cut is being taken. The position of the feed-changing lever always shows by the raised figures on the lever quadrant just how fast the machine is feeding; this gives the foreman an exact index as to what the operator is doing at all times, which is recognized as a very valuable feature by up-to-date mechanics.

This machine finds its chief application in railroad shops in milling driving boxes, connecting-rod brasses and work of a similar character. Fig. 1 shows one of these machines in operation on some work which will give an idea of how this class of work is handled. In this case the material is cast iron and the recess being milled is 6 ins. wide and 15-16 in. deep. The entire width of the gang of cutters is 7⅝ ins. and the largest cutter is 4½ ins. in diameter, with a 6-in. face. The cutters work at a surface speed of approximately 47 feet per minute. The roughing cut takes out about 3-32 in. all around with a feed of .075 in. per turn of cutter, which is equivalent to a table travel of 3 ins. per minute. Then the feed is reduced by means of the quick feed-changing mechanism, described above, the cutters are changed and a finishing cut is taken, removing about .010 in. all around at the reduced feed of .036 in., or nearly 1½ ins. table travel per minute. On this job two cuts are taken because extreme accuracy is required, the finished pieces coming within a limit of .001 in.

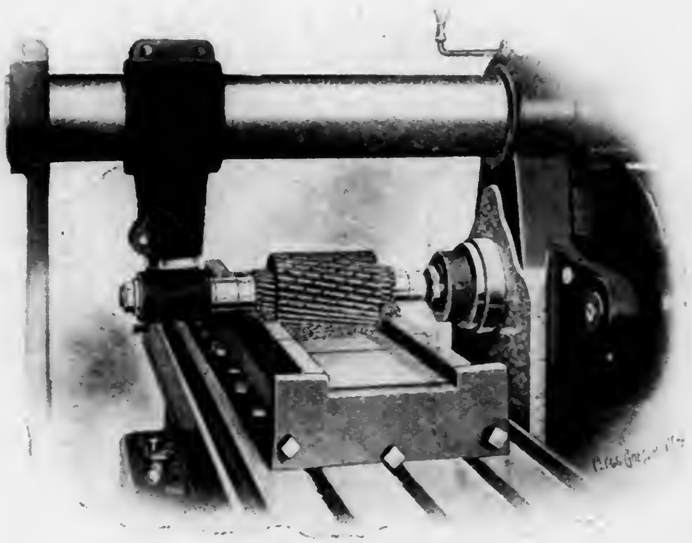


FIG. 1. AN EXAMPLE OF RAPID MILLING.

This company also makes universal milling machines which are especially designed for tool-room work, for which the No. 3 size has been most popular. This machine has a table 12 ins. wide, with 30 ins. travel, and weighs approximately 1,000 lbs. It has the same feed mechanism as that described above for the No. 4 plain miller, and on both machines there are 16 changes in the rate of feed, the slowest feed being .006 in. and the fastest feed being .300 in. per revolution of cutter.

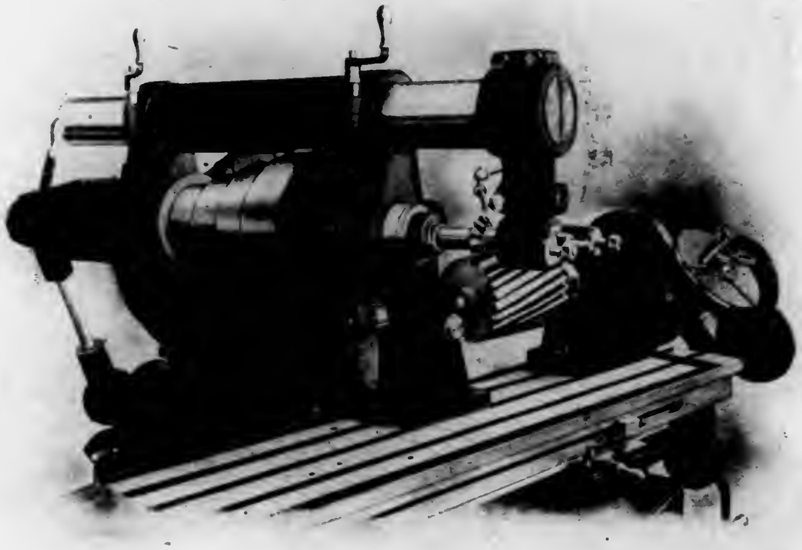


FIG. 2. A NEW RECORD IN MILLING STEEL.

Fig. 2 is an illustration of this latter machine in operation. The blank being milled is made of unannealed tool steel, 5½ ins. diameter, and the teeth are cut at a 14-deg. angle. The grooves are ½ in. deep and about ¾ in. wide at the top. The stock is removed at a table feed of ¾ in. per minute, the machine working quietly without any chatter. A light finishing cut is then taken at a table feed of 1 5-64 ins. per minute. This beats all records even over the larger machines of other makes and several of the best-known cutter makers in the world have adopted this machine as their standard. The machine shown in Fig. 2 is the regular universal machine with the exception of the spiral head. In this case a head made especially for spiral work is substituted for the universal indexing and dividing head regularly supplied with the machine. The Cincinnati milling machine has been installed in the shops of a large number of prominent railroads in the United States.

The Cincinnati Milling Machine Company have pamphlets illustrating characteristic milling operations and giving complete data of same, which they are always pleased to send to parties interested. The interesting feeding mecnanism of these machines will be taken up in detail in a later issue of this journal.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of this society was held in New York December 2 to 5, the presiding officer being Vice-President Arthur M. Waitt, who presided ably in the absence of the president. The first and last sessions were held in the rooms of the society and the others in the banquet hall of the Sturtevant House, near at hand. In accordance with a recommendation from the council the following committees were appointed: To co-operate with the American Institute of Architects in tests of large I-beams, Messrs. H. de B. Parsons and Professor Palmer C. Ricketts. As a committee on the standardization of screw threads, Messrs. Wilfred Lewis, G. R. Stetson, G. M. Bond, C. C. Tyler and John Riddell. To represent the society on the committee to fix the next award of the John Fritz medal, Prof. G. Lanza, Prof. J. E. Sweet, S. T. Wellman and R. W. Hunt. Ninety-three names were added to the list of membership.

The subject to which most time was given was the metric system, which was vigorously attacked in a paper by F. A. Halsey, who proved conclusively that experience with the metric system in other countries justified the conclusion that if adopted by a compulsory law in the United States for the business of all departments of the government, the result would be an addition to the confusion already existing. He showed that the metric countries have, in a large degree, maintained their former systems and the ideal conditions expected from the metric system have not been attained abroad. An altogether undue amount of time was given to this subject, the discussion being decidedly unfavorable to the system and resulting in a resolution to the effect that the society has never, officially, withdrawn its opposition to it.

Among the other papers was one by Mr. Wm. Kent, entitled "Heat Resistance the Reciprocal of Heat Conductivity." Mr. Kent advocated the use of reciprocals of the usual values of heat conductivity so that the conductivity of a combination of substances may be obtained in the same manner as is the case in electrical work. Mr. Chas. T. Porter presented a paper constituting an argument for finer screw threads. Mr. C. C. Tyler described the use of a surveying instrument in the floor plate work of the machine shop of the General Electric Company at Schenectady. Mr. Frank Richards discussed "Gift Propositions for Paying Workmen," in a paper which was, by far, the most important of the meeting. This paper is discussed, editorially, in this issue. The discussion developed the fact that the author of the paper was in the minority. Most of the speakers took the ground that it was not necessary to give all the advantage of increased output to the men and that the management should have a direct profit in order to accomplish reduced cost per piece for the work turned out. While Mr. Richards' view was not a popular one, it behooves men in charge of industrial establishments of all kinds to consider his criticisms most carefully. It is hoped that our readers will secure copies of his paper from Professor F. R. Hutton, secretary of the society, 12 West 31st street, New York. Of the remaining papers the most important was by Professor A. Kingsbury, describing a new oil testing machine and its results, which were remarkable in uniformity.

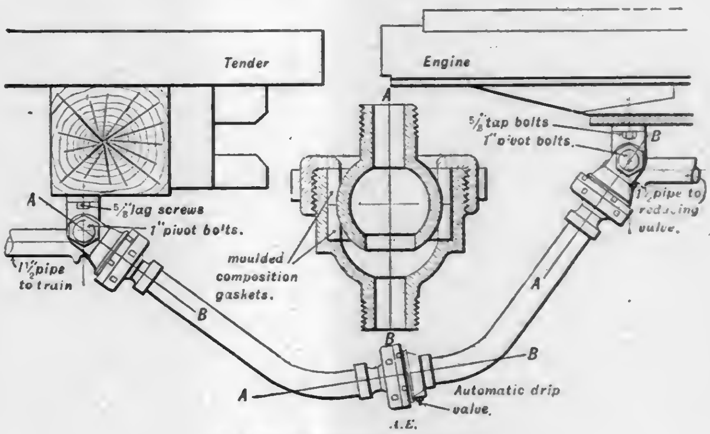
In this entire meeting there was no direct reference to railroad subjects and the proceedings can hardly be said to have reflected the progress which has been made in a number of other lines of engineering. There is an undercurrent of criticism on this account. The election of officers resulted as follows:

President, James M. Dodge, Philadelphia; vice-presidents, F. H. Daniels, Worcester, Mass.; James Christie, Philadelphia, and J. R. Freeman, Providence, R. I.; managers, R. C. McKinney, New York; S. S. Webber, Trenton, N, J., and Newell Sanders, Chattanooga, Tenn.

THE MARTIN FLEXIBLE METALLIC CONDUIT.

For steam, oil, water and air connections between locomotives and tenders a more permanent material than rubber hose has been sought. The Holland Company have introduced a new form of metallic conduit with flexible joints which seems to meet the necessities of such service admirably. Such connections must not only be durable and flexible, but they must be steam-tight, and for oil, which is not usually under high pressure, the test of tightness is a severe one for a flexible joint. After more than three years of experimental work Mr. J. C. Martin, Jr., has developed the conduit which is illustrated by this engraving, and the writer of this description has watched tests of the joints under high steam pressure where there was certainly no leakage.

As shown in the sectional view, the tightness of the joint does not depend upon a fit of metal to metal, as the metallic surfaces do not come into contact. For this reason the metal surfaces will not wear out. Around the ball are placed two gaskets of hard material specially manufactured for this purpose. They are molded to fit the ball and are interchangeable. One of these gaskets receives the wear of the joint while the other makes it tight. A sleeve nut holds the joint together and the gaskets may be easily renewed when necessary without disturbing the threaded pipe connections. The material of the gaskets furnishes its own lubrication and in ordinary service they are expected to give a service of one year. The engraving also shows the complete conduit with three joints. The center joint has a straight passage with more than the full opening of the pipe, while the others must necessarily cause a quarter turn in the passage. An important feature of the device is the fitting containing the angle bend. It is of malleable iron and is fastened by a bolt to a malleable iron supporting casting secured to the engine and tender frames. These fittings provide a flexible attachment without in any way placing a strain on the piping. Moreover, this form of attachment provides for a considerable difference in elevation of the ends of the conduit by merely changing the angles, as indicated in the engraving. In all the joint fittings the passages are larger than the area of the pipe. All of the parts, including the pipe, are furnished complete, ready for attachment. Bronze is used for the joints and malleable iron for the attachments. The joints are fitted with automatic drip valves, as indicated. It will be noticed by examining the sectional view that this joint does not depend upon the pressure of the fluid for its tightness.



MARTIN METALLIC CONDUIT.

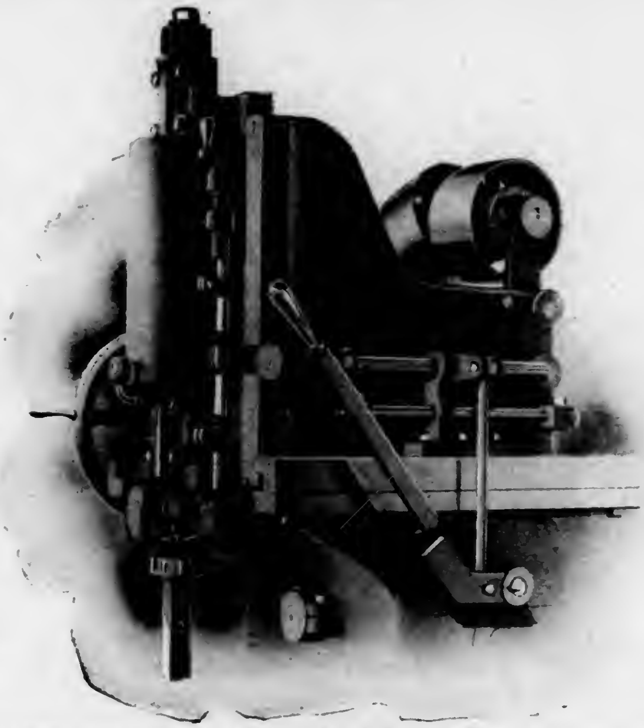
The conduits have been put into service on a number of leading railroads and satisfactory results are reported. The chief offices of the Holland Company are at 77 Jackson Boulevard, Chicago. Other offices have been established in New York and in San Francisco.

VERTICAL HOLLOW-CHISEL MORTISER.

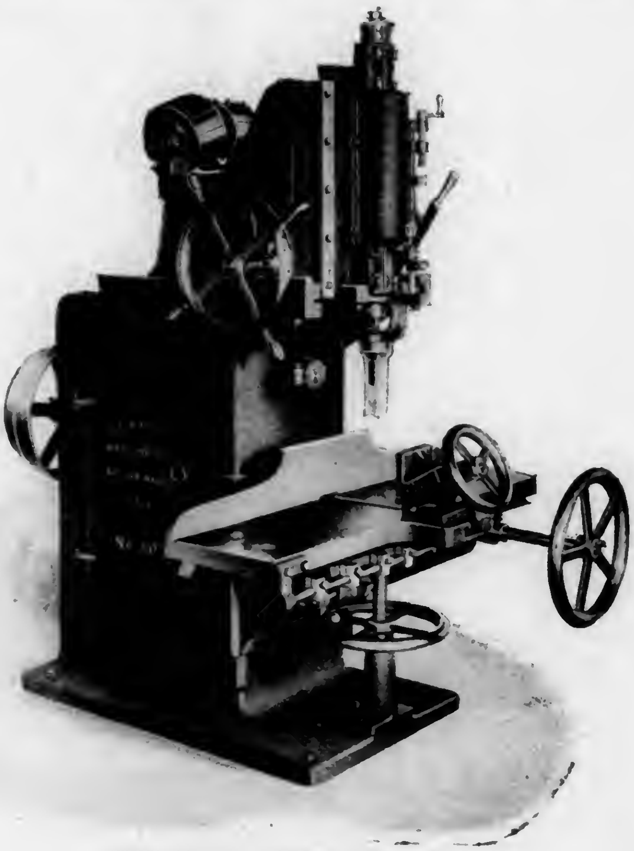
S. A. Woods Machine Company.

These engravings present a new vertical, automatic, hollow-chisel mortiser which has received the best thought and is the result of the wide experience of this well-known concern. It is built for fast and economical work and an inspection of the engravings gives the impression of the same sort of care in designing the machine as is given to the highest grade machine tools which are absolutely indispensable to railroad officers who are engaged in efforts to conduct their work upon business principles. Nowadays the convenience of the operator must be considered or the operation of a machine cannot be economical. In this case all of the operating and controlling devices are placed within easy reach and they do not require even a step in the manipulation. This is exceedingly important. A machine must be convenient to the operator.

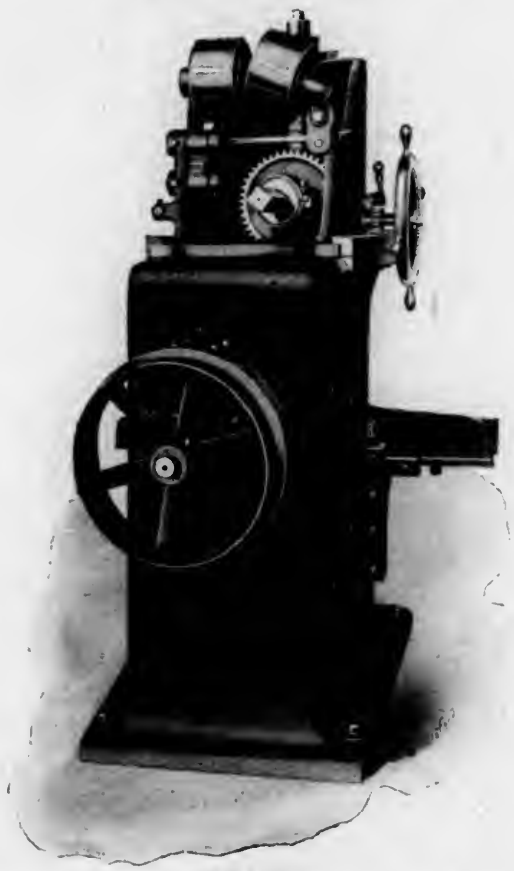
Among the special features of the construction the following attract our attention: The lay-out stops for laying out mortises should contribute to quick and accurate work. For taking up the end thrust of the spindle and supporting it, an improved step bearing, running in a bath of oil, is provided. The machine has a new device for instantly changing the depth of the mortise. The spindle belt is kept tight by an automatic belt-tightener, which is seen in the rear view. When the chisel is located in position it is locked by a novel clamping device and the chisel carriage has a transverse movement with adjustable stops for regulating its travel. In this respect the machine presents a new feature for a medium-size machine and one which is sure to be appreciated. The table has both vertical and longitudinal movements, the chisel ram being also vertically adjustable. The timber clamp is very strong and is adjustable as well as detachable from the table. Improved friction feed with two speeds is provided, with quick return. To prevent air-cushioning of the belts a patented pneumatic spindle is employed.



SHOWING DEVICE FOR CHANGING DEPTH OF MORTISE. ALSO, LAYOUT STOPS FOR TRANSVERSE MOVEMENT.



VERTICAL HOLLOW-CHISEL MORTISER.



REAR VIEW.

The chisel ram has a vertical travel of 9½ ins., the chisel carriage moves horizontally 18 ins. and will drop to mortise stock 17 ins. high with a 6½-in. chisel. Timber up to 12 ins. may be clamped and chisels up to 1½ ins. can be used on hard wood. The floor space occupied is 4 ft. x 5 ft. 8 ins. The manufacturers present the machine with confidence. They say: "This is a machine we are extremely proud of and we cannot say too much in its favor." This of itself is a strong recommendation. Further information may be obtained from the S. A. Woods Machine Company, South Boston, Mass.

THE DE LAVAL STEAM TURBINE COMPANY'S NEW FACTORY.

An interesting and enjoyable feature of the New York meeting of the American Society of Mechanical Engineers last month was a trip to the factory of the De Laval Steam Turbine Company at Trenton, N. J., which was tendered to the members by the D'Ollier Engineering Company, of 74 Cortlandt street, New York, the contracting engineers for the installations of the De Laval turbines. Access was given to the machine shop and the testing room of the factory, where the turbines were to be seen in all stages of assembling and testing, and in all sizes from the smallest up to 300-h. p. units.

The compactness of the De Laval turbine, due to its characteristic high speed, was made particularly evident; a blade-disc for a 50-h. p. turbine was shown which is only 9 ins. in diameter and runs at a speed of 20,000 revolutions per minute, giving thus a circumferential velocity of about nine miles per minute. The blade disc for their largest unit, the 300-h. p. turbine, is only 30 ins. in diameter and runs at a speed of 10,000 revolutions per minute, giving a circumferential velocity of over 15 miles per minute. This high speed is not utilized directly, but the power is delivered through a 10 to 1 reducing gearing consisting of two pairs of carefully cut spiral gears, each pair of which has oppositely inclined spirals, so as to produce the herring-bone gear effect and neutralize thrust. The result of this combination is very smooth and quiet running.

One remarkable property of these turbines is their economy; they have proved so economical that the makers can very easily guarantee a steam consumption of only 15½ lbs. of steam per brake horse-power-hour. They also have proved almost as economical at partial loads as at full load. A remarkable performance is accomplished by the 300-h.p. turbine-generator set which has supplied the factory since its opening—it is now running 24 hours per day, on account of the night shift, steadily without shutdown throughout the week. It would be a rare service for a reciprocating engine to run 130 hours per week between shutdowns without giving trouble.

MECHANICAL STOKERS IN ROLLING MILLS.

Perhaps the severest character of load encountered in modern steam-supply service is that encountered in the operation of steel rolling and slabbing mills. The fluctuations in the demand for steam are not merely of the nature incident to a street-railway load, which is usually considered of maximum severity, but they frequently involve the capacity of the entire plant. In one American steel plant there have recently been put into operation slabbing mills consuming as much as 2,000 horse-power during the working of a large steel "bloom." This load is approximately uniform until the "bloom" leaves the rolls, when it instantly decreases to that of mechanical friction only. It is apparent that in order to effectually accommodate these excessive variations in steam supply either a considerable storage capacity must be provided in the boiler equipment, permitting uniform firing, or quick steamers must be employed, fired by some form of mechanical stoker. At the present time the latter arrangement is rapidly coming into use, with the result that fluctuating loads are readily anticipated and cared for by control of fuel combustion. This control may be rendered automatic when mechanical draft is employed in connection with the boiler and stoker equipment. A prominent example of this arrangement is offered in the plant of the Lukens Iron and Steel Company, which comprises 5,700 horse-power capacity of Babcock & Wilcox water-tube boilers equipped with Roney improved duplex stokers and a complete mechanical draft outfit. In this plant the speed of the fans and the position of the flue-dampers are automatically controlled by the pressure of steam in the supply-main, thus proportioning the rate of combustion to steam demand. In the operation of this plant it has been found unnecessary to continue the signal system formerly in use between fire-room and slabbing mill, and the heaviest demands for steam are readily provided for by the automatic arrangement for control of draft in connection with the mechanical stokers.

A new device for the delivery of train orders to engineers and conductors of trains in motion has been patented by Mr. Amos McKanna, of Emporia, Kan. It consists of a clip holding the train order, which is suspended on a large wire ring. The ring is held in clips from the end of a rod, which is held in the hand of the operator, and the ring with the train order is easily caught by the arm of the men on the engine and caboose. For use at night a torch on the end of the arm may be lighted in order to attract attention and permit of sure operation of the device.

BRAZING CAST-IRON.

At a meeting of the Foundrymen's Association of Philadelphia, December 3, Mr. H. Armor Ward, president of the American Brazing Company of 136 South Fourth street, Philadelphia, explained in detail a new process.

In the course of his remarks Mr. Ward stated that the discovery of the process of brazing cast iron had changed the methods in European foundries with reference to complicated castings, especially in the case of large castings where a flaw or imperfection of any kind involved the relegation of the piece to the scrap pile.

The patterns were now cut into two or more parts, so that each was a simple piece to mold, and the several parts that went to make up the whole were brazed together, and the cost of production had been materially reduced, in that the cost of brazing was very much less than the cost of molding one large casting, as against two or more smaller pieces.

Mr. Ward explained that flaws in castings were eliminated by drilling them out if they were small, and brazing in a plug made to fit the hole. If they were large, and in the nature of a crack, if the crack was wide, a piece of any kind of iron was fitted into the space, and brazed into place. If narrow, the crack was cleaned out thoroughly and brazed up. If it could not be cleaned in this way, the fracture was extended by hammering, until the entire break could be reached to clean, even if this involved breaking the piece entirely in two. The cost of the "ferrofix" involved was about half a cent per square inch of surface brazed.

In tests made for the Government in Berlin, at the Stevens Institute in Hoboken, at the University of California, and by the Pennsylvania Railroad, it had been demonstrated that the brazed joint was not only stronger than any portion of the casting of equal section, but that the strength of the iron adjacent to the joint was increased perceptibly.

With the practice in Europe in mind, Mr. Ward asserted his belief that the introduction of this brazing process must affect shop practices as radically as was the case there. As the result of his investigations in Germany, France and Belgium, Mr. Ward stated in his judgment at least 75 per cent. of the flaws that ordinarily destroy the value of a casting could be eliminated, and the piece made sound and serviceable at a small fraction of the cost of remolding. Several small pieces were exhibited, but as there were no means of testing the strength of the joint, it could not be determined just how satisfactory the joints were for strength, although to all appearances the pieces were as sound and strong as if they had been molded perfectly.

The chief peculiarity of this process of brazing is that it is always perfect when the work is properly done. Its simplicity and cheapness were remarkable in view of the fact that in brazing steel or brass an expert in that art is usually required, in order to insure having a good job, but in "ferrofixing" by the American Brazing Company's process no expert skill was required. The alignment of the piece was unchanged, the surfaces, whether machined or not, were not disturbed in any way, and after the completion of the brazing operation all that was necessary was to clean off the surplus brass, and the piece would be found as sound and true as a perfect casting.

BOOKS AND PAMPHLETS.

Transactions of the American Society of Mechanical Engineers. Vol. 23. Annual Report for the 44th and 45th Meetings. 878 pages, illustrated. Published by the Society, from the Library Building, No. 12 West 31st St., New York City.

This volume contains the reports presented at the New York meeting of the Society for 1901 and at the Boston meeting for 1902. An interesting list of subjects is presented, the most important among which are the reports of the committees on standardizations and upon the Bursting of Flywheels, by Mr. Benjamin; but it is to be noted that reports and investigations upon railroad subjects are conspicuous for their entire absence.

Index of Proceedings of the Master Car Builders' Association. From Volume I. to Volume XXXIV., Inclusive. Compiled by George L. Fowler, J. W. Taylor, Secretary, 667 Rookery Building, Chicago, Ill. Price, by mail, $1.10.

This volume of 244 pages presents a complete and satisfactory index of the valuable work of this association, rendering its reports, papers and discussions available in a way which was impossible before because of the difficulty of finding desired information. The association is to be congratulated upon this index itself and upon the admirable manner in which it was prepared. The work was done by Mr. George L. Fowler under a committee of the following members: Messrs. D. F. Crawford, F. M. Whyte and W. A. Nettleton.

Metallurgical Notes. By Prof. Henry M. Howe, Columbia University. Published by the Boston Testing Laboratories, 446 Tremont Street, Boston, Mass. Price, $2.50.

This book marks a distinct step forward in the progress of instruction in metallurgy, and gives a carefully planned series of experiments which cover many of the fundamental principles. The experiments are so arranged as to compel the greatest amount of thinking and of careful and exact observation, and to reduce to a minimum the play or mechanical side of laboratory practice. Much general instruction is also given, and the reasons for each step are stated clearly and concisely. References are given copiously, and a good index makes the book useful for reference. We heartily commend it to every student of metallurgy.

American Railway Engineering and Maintenance of Way Association. Proceedings of the Third Annual Convention, 1902.

This volume contains the rules and record of business, lists of subjects and committees, in addition to the proceedings of the convention of last spring. Among the papers are several of special value, as follows: "Improvement of Grades and Alignment"; "Ties, Timber Supply, and Preservation of Wood"; "Rail Sections, Yards and Terminals, and Coaling Stations." There are also other important papers, but these are mentioned as being specially worthy of preservation. Thoroughness and business-like procedure characterize the work of this organization, and its proceedings constitute the best available record of present practice in maintenance of way. Presumably copies of the pamphlet may be obtained from the secretary, Mr. L. C. Fritch, Room 1562, Monadnock Block, Chicago, Ill.

Smithsonian Institution. Annual Report of the Board of Regents Showing Operation of Institution and its Present Condition. 782-pages, 8vo, profusely illustrated, with insert plates. Published by the Government Printing Office, Washington, D. C. For sale at cost.

This popular volume for 1901 contains fifty articles nearly all prepared by masters of the respective subjects, telling in clear and interesting language of the latest progress in all the principal branches of knowledge. "Bodies Smaller than Atoms," "The Greatest Flying Creature," and "The Fire Walk Ceremony of Tahiti," give evidence of the wide range of subjects included in the report. Wireless telegraphy, transatlantic telephoning, and the telephonograph are discussed by experts in electrical progress. Attention ought also to be called to papers on utilization of the sun's energy, the Bogosloff volcanoes of Alaska, forest destruction, irrigation, and the submarine boat.

Graphic Method of Solving Certain Questions in Arithmetic or Algebra. By George L. Vose, Professor of Civil Engineering in Bowdoin College. Van Nostrand Science Series. Second edition. 62 pages, with numerous diagrams. Price, 50 cents.

This is a second edition of the reprint of the valuable article which appeared in Van Nostrand's Engineering Magazine for June, 1875. The method described is the one that originated in and was suggested by simple mechanical movements, but was shown to be applicable to very intricate and complicated movements, and has been used to a very large extent for a great many years by railroad companies for the adjustment of the running times of trains. The method set forth is too well known to need comment, being still in use on a large number of the prominent roads of this country. This second edition of the work will bring it again into print, so that it will be available for those not familiar with it.

Mechanics Problems. For Engineering Students. By Frank B. Sanborn, Professor of Civil Engineering in Tufts College. 8vo, 155 pages, illustrated. Published by the Engineering News Publishing Company, New York, 1902. Price, $1.50.

This volume presents a very complete list of 500 problems, with answers, relating to applied mechanics. They are similar to problems presented in many text-books, but many of these have been developed from the conditions of actual practice, and thus are intended to fulfill all requirements for thorough and interesting instruction in the applications. This volume is not intended to take the place of text-books or lecture notes, but rather to be used in conjunction with them, in order to correlate more closely the every-day practical examples with the important laws of mechanics. The problems have been arranged by subjects in the following order, Work, Force and Motion, which order is considered the best. A very complete and well-arranged index to the problems is appended.

Manual for Steam Engineers and for Owners of Steam Apparatus *(Manuel du Chauffeur-Mecanicien et du Proprietaire d'Appareils a Vapeur)*. By Henri Mathieu, *Controleur Principal des Mines, Inspecteur des Appareils a Vapeur de la Seine*, etc. Second edition, entirely revised and considerably enlarged. 892 8vo pages. Printed in French. Profusely illustrated. Published by Ch. Beranger, 15 Rue des Saints-Peres, Paris, France.

This is a very complete treatise on the subjects of steam, steam generation and steam engines, with particular reference to modern French practice. No pretentions are made toward a scientific treatment, the work being addressed more to practical men and toward a practical, though very complete, treatise on apparatus. The work is divided into three parts—Boilers and Receivers; Engines, Valves, etc., and Laws and Legislation governing the use of steam. Only a few pages are devoted to the locomotive, the work being essentially devoted to stationary practice, but as an exposition of the details of engines and steam machinery it is not to be excelled.

Machine Shop Arithmetic. A Pocket Book of Practical Problems. By Fred H. Colvin and Walter L. Cheney. Third edition, 1902. 131 pages, with diagrams and tables. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 50c.

This valuable little work has been revised and enlarged to bring it up to modern practice in every particular. It contains chapters on the foundation principles of arithmetic, on square root, cube root, and principles of screw-cutting in lathes, in which, instead of giving just rules and examples, it is endeavored to show *why* each step is taken, so as to assist the reader in reasoning out problems instead of following rules implicitly. Explanations in clear language of the principles on which the methods of solution are founded are characteristic of this book, and are what give it especial value. We cannot refrain upon commenting also upon the artistic manner in which the binding and typographical work were handled; the quality of the paper is excellent and the binding is very attractive. The high-grade work exhibited in this little volume bespeaks a bright future for the Derry-Collard Company, of which Mr. Colvin is president.

The Design of Simple Roof-Trusses in Wood and Steel. With an Introduction to the Elements of Graphic Statics. By M. A. Howe, C. E., Prof. of C. E. at Rose Polytechnic Institute. 129 pages. 8vo. illustrated. Published by John Wiley & Sons, 43 East Nineteenth Street, New York. Price, $2.

This book was written to bring together into small compass all the essentials required in properly designing ordinary roof-trusses in wood and steel. At present such information is widely scattered and does not exist in a single book, so that it was thought this work would fill a long-felt want for students of engineering who have not devoted particular attention to civil engineering studies. It will, however, do more than this—it will meet the demands of the great number of those who have not had the advantages of a technical education, as it gives clearly and concisely all the information necessary and, besides, presents three actual examples of complete designs for wood and steel roof-trusses all

worked out in detail for a guide to future designs. It contains very little mathematics that cannot be easily comprehended, and gives in the appendix a large list of tables regarding roof coverings, the various structural materials and properties of the various commercial shapes. This work is arranged in the convenient and practical manner that we like to see, and is highly recommended to anyone desiring such information.

A Manual of Drawing. By C. E. Coolidge, Assistant Professor of Machine Design, Sibley College, Cornell University. 92 pages, 8vo; 10 full-page plates. Published by John Wiley & Sons 43 East Nineteenth street, New York. Price, $1.

Probably no branch of engineering has had more books written about it than that of mechanical drawing, and with more indifferent success. The great majority of such books are mere compilations into book form of the methods of teaching the subject of some instructor, without purpose other than that of presenting the entire subject in restricted space, with the result that too little of any part is given. The above-named book by Mr. Coolidge is not an attempt to cover the whole field, but is a small work of 92 pages with a definite purpose to fulfil, viz., that of presenting to students a single-standard drafting-room system. It is impossible to present this subject by lectures in the class-room without more or less confusion to the student, and so the object sought here is to present a single system and to do it thoroughly and well. The first 80 pages of the work are taken up with an exposition of standard drawing materials, instruments and methods of using them; the remainder is devoted to instructions regarding commercial mechanical drawings, and is accompanied by 10 full-page plates at the back of the book. The work is regarded by the author as incomplete, for which reason every other page is left blank to permit the addition of notes as found necessary. This book is a step in the right direction to reclaim the technical graduate of the future from his present state of educated helplessness and substitute the practical education so universally desired.

The Derry-Collard Company, of 256 Broadway, New York, have issued a 44-page pamphlet giving a carefully selected list of books for railroad men. The method pursued by this company is to send any book desired, on approval, to be paid for if retained and to be returned if it does not prove to be the one wanted. The pamphlet gives the titles of books, the prices and a brief statement of the character and value of the work. It would pay the railroads of this country to supply their mechanical department drawing rooms with books from this list.

Motor and Trailer Trucks.—This is the title of Record of Recent Construction No. 38 of the Baldwin Locomotive Works, which describes the development of the electric motor trucks of those builders and illustrates a large number of trucks for American and English passenger service of elevated and underground roads and also for the heavier class of electric interurban service. This firm have applied to the construction of these trucks their long experience in locomotive work, and the pamphlet is an interesting record of their progress and practice.

The Ferguson Portable Heater and Kindler is described in a pamphlet received from the Railway Materials Company, Old Colony Building. This device has been on the market only two years and has been adopted by 38 railroads in the United States for many important operations in connection with car and locomotive repairs. The machine consists of a tank mounted on wheels, which is connected to a source of supply of compressed air, and a very hot flame is produced by a portable burner attached to a hose, the flame of which is produced by the combustion of air and the cheapest grade of crude petroleum. The portability of the machine and the convenience in operation and regulation render the device exceedingly convenient for emergency roundhouse repairs, such as heating locomotive frames for bending, straightening bent ashpans, shimming tires, heating tires for removal, and similar work. The heater is also used in repairing steel cars where an intense local heat is required for bending distorted plates and members. Another use is lighting fires on locomotives. The remarkable success obtained by the Ferguson furnaces manufactured by this concern is sufficient guarantee of the success of this new device.

"Jeffrey Water Elevators" is the title of a recent special catalogue from the Jeffrey Mfg. Company, Columbus, Ohio, illustrating and describing various systems of raising water developed by them. Chain bucket water-elevators for operation by power are shown geared for horse-power or other driving methods.

Steel as a substitute for wood in laths is making rapid progress in building construction. The Cambridge Rigid Reversible Metal Lath is made of steel and is well suited for either inside plaster or outside cement construction. It is proof against fire, damp, cracks, vermin and sound. For inside work it is permanently protected by the plaster and for outside work permits of cement construction, giving the appearance and durability of stone. This lath is the subject of an illustrated folder received from the American Sheet Steel Company, Battery Park Building, New York, the manufacturers.

The Rand Drill Company, 128 Broadway, New York, have issued a new catalogue of "Imperial Air Compressors." This pamphlet contains a thorough description, with detailed information, of "Imperial," Type 10 and Type 11 air compressors. Type 10 is a horizontal machine, combining the many special features of the machinery of this firm, and Type 11 is a vertical machine to meet requirements of compactness, simplicity and strength. The "Imperial" unloader is also described. Tables are included, giving the capacity, indicated horse-power, dimensions and weights of these machines in various sizes.

Thread milling machines are described in an illustrated catalogue which the Pratt & Whitney Co. have prepared for distribution. This is a comprehensive pamphlet, of which the company should be proud. It presents the subject of thread milling, describes the machine, illustrates the proper method of driving it, and shows by beautiful engravings the product which it will turn out. The object was to produce a method of cutting threads which will be better, more accurate and more economical in performance than the engine lathe methods which have been used for thirty years. The following results were sought: Uniformity, exact pitch, smooth finish, large output, low cost, and these to be secured with unskilled labor. The saving made possible by thread milling is estimated at from 25 to 500 per cent. The pamphlet opens with a clear and concise description of the machines, the cutters, fittings and driving mechanism. It then presents engravings of the product, including threaded rods, solid end springs, worms and spiral gears. Following these are tables of gears for English and metric threads, tables for setting the cutters, and the pamphlet closes with an illustrated description of the automatic cutter-grinder designed specially for these machines, which renders the sharpening of the cutters an easy task. This is an important addition to the product of the firm, and the presentation in the pamphlet is in every way worthy. Better engravings are not to be found anywhere, and in other respects the pamphlet is an example to machine-tool builders.

The name of the Broderick & Bascom Rope Company, of St. Louis, has been long associated with successful practice in the use of wire ropes, and any contribution from them on this subject commands attention. A handsome pamphlet entitled "Underground Wire Rope Haulage" has just been prepared for them by Mr. William E. Rolfe. It presents the successful application of this system in the workings of the Coal Valley Mining Company, at Sherrard and Cable, Ill., and is one of the best examples of literature of this kind that we have seen. The pamphlet shows the relation between wire-rope haulage and the output of mines, especially in the fact that it provides an inexpensive and effective method of collecting the cars to a central point. The conditions of mining require absolute reliability, and that is given by this method. Three systems are described—the inclined plane, the endless rope, and the tail rope. These are illustrated by excellent engravings made from flashlight photographs taken in the mines. The descriptions are of actual construction, and the commercial question of comparison between mule and rope haulage is presented. This pamphlet will interest mine officers and also engineers who are engaged in work requiring wire ropes for any purpose. An interesting case of an old rope, after it had been in continuous service for four years, is illustrated. The address of the Broderick & Bascom Rope Company is 809 North Main street, St. Louis, Mo. Copies may be had on application.

"Tropenas" steel castings are described and illustrated in a pamphlet received from the American Brake Shoe and Foundry Company. This process of making cast steel is specially adapted to the manufacture of small castings which may be used in place of forgings and malleable and gray iron castings. In the pamphlet the process is described and the merits of this steel are set forth. On every page is an engraving illustrating a very large variety of castings for which this metal is used. As a substitute for forgings this metal saves the labor of forging; as a substitute for malleable and gray iron forgings it offers a better material, with greater strength and ductility.

The monthly publication, Dixon's Graphite, for December, contains an interesting article on experiments by Prof. W. F. M. Goss, of Purdue University, in the use of Dixon's graphite in air-brake equipment. The experiments were made upon the 50-car train equipment at the university. The experiments covered the use of vaseline without graphite, graphite without vaseline, and finally the use of graphite and vaseline. The experiments are not only of interest but of value to all who are connected with or interested in locomotive engineering. The important conclusions of the test may be stated as follows: 1. Graphite alone is not a sufficient lubricant for triple valves. 2. After graphite has been well rubbed into the working surfaces of the valves, and after this process has been followed by thorough oiling with vaseline, the action of the triples was more delicate and more rapid than with vaseline alone, prior to the use of the graphite. 3. The presence of the graphite on the metal surfaces of the valves, when operated with vaseline as a normal lubricant, serves to improve their action in a marked degree.

The Crane Company, Chicago, Ill., have recently issued a pocket edition of their complete catalogue. The contents are practically identical with those of their recently issued general catalogue, their standard-pressure valves and cocks in brass and iron being illustrated and described, as well as their very complete line of fittings, their high, medium and low-pressure fittings, gate valves and flange fittings, and engineers', steam and gas-fitters' tools and supplies. This little volume, which is 4½ by 7 inches in size, has 464 pages, and is bound in buckram, making it a very serviceable handbook. It is now ready for distribution, and may be obtained by writing to the home office or to any of the branch offices of the company.

The Case Steam Engine.—The New Britain Machine Company, of New Britain, Conn., have prepared a 40-page pamphlet illustrating and describing the Case automatic high-speed engine built by them. This engine is constructed in three forms, all embodying the same principles. The first is a pedestal engine, for attachment to a floor or foundation; the second is a bracket engine, to be bolted to a wall, and the third is a hanger engine, a novelty originated and manufactured by this company, to be bolted to an overhead beam. These engines are built in a large variety, and are specially adapted to use in direct-connected generator sets. The pamphlet is one of the most complete we have seen on the subject of the small steam engine, and in it are illustrated a number of interesting applications. Copies of the pamphlet may be had upon application.

The Gates Rock and Ore Breaker is well known all over the world for its simple construction, great capacity and durability. Over 5,000 of these machines are now in use in all parts of the civilized world. This statement alone is sufficient ground for implicit confidence in this machine and the concern manufacturing it. Under the title of "Mining Machinery" the Allis-Chalmers Company have issued three pamphlets devoted to these crushers, and they should be in the hands of everyone requiring crushing machinery. Book No. 1 illustrates and describes the construction of the crushers in detail, and also presents the new "Style D" machine. The Gates works have been engaged for twenty years in the manufacture of gyratory crushers, and during that time they have not lost an opportunity to apply their intimate knowledge of the requirements of this class of machinery to its improvement. The word "gyratory" indicates the character of the mechanism. The material is crushed between a cone upon a gyratory shaft and a shell which forms a part of a very strong case. The shaft is vertical and its upper end is rigidly held in a bearing while the lower end is gyrated by means of a gear-driven eccentric. The crushing cone impinges against the sides of the shell, its motion causing it to continually approach and recede. The crushing is done against a concave surface of the shell, which tends to make the broken parts take a cubical form. This form of machine, owing to its circular construction, has about three times the capacity of the jaw type of machines. Other advantages claimed for it over the jaw machines are finer crushing, absence of vibration, and much less power required for driving. For crushing ballast and preparing broken stone for concrete these machines are specially well adapted. They are made in sizes up to a capacity of 150 tons of road material per hour, and these operate at a cost of less than 2 cents per ton. This concern also manufactures sample grinders, fine crushers, hoists, screens, and everything pertaining to this class of machinery. Book No. 4 describes complete crushing plants, and another pamphlet contains a list of users of the machines and letters reporting satisfactory operation. One prominent feature of these is the testimony with reference to durability and low cost of repairs. Farther information may be had by addressing the Allis-Chalmers Company, Chicago, Ill.

INDUSTRIAL NOTES.

The Q. & C. Company have shipped from their factory at Chicago Heights, Ill., one of their largest special metal sawing machines to the United States Government, to be used at the navy yard at Cavite, Manila.

H. B. Underwood & Co., manufacturers of special tools for railway repair shops, 1025 Hamilton street, Philadelphia, inform us that Mr. Daniel W. Pedrick is no longer connected with or interested in any way with the Pedrick & Ayer Company. His entire time is now given to H. B. Underwood & Co., of which firm he is the senior partner. He has been a partner of this firm since its organization and is now engaged in manufacturing portable cylinder boring bars and other portable tools for railroad shops, of the same high grade and quality as he did when connected with the Pedrick & Ayer Company.

The Stewart Hartshorn Company, February 1, will move their New York stock rooms to No. 7 Lafayette place, one block east of Broadway, between Great Jones street and East Fourth street, a central location for all interested. For the past thirty-four years Hartshorn shade rollers have been in stock at 486 Broadway, a location well known to the trade, and although it is a rare thing to see old firms move, it was deemed best by the company in this case. Trade has been increasing, as well as demands for the many improvements which the company has brought into the construction of their shade rollers and accessories, so that in order to carry the necessary stock for immediate shipment in New York it was found necessary to acquire much larger storerooms. At No. 7 Lafayette place the main storeroom is on the ground floor, besides which the company will also occupy the basement, which is equal in area to the main storeroom. This gives more than double the space formerly occupied so long on Broadway, and here will be carried a full line of new groove tin and improved wood rollers, as well as the older styles of Hartshorn shade rollers, which are still called for by some dealers. Besides these, a full line of shade-roller brackets, pin ends, shade clasps, bottom roller clips, catch pulleys, etc., will be found; also models showing the various methods of placing shades properly in position. To these new stock-rooms the Stewart Hartshorn Company cordially invite their friends. With more room and fuller stock, quick demands can be promptly met. In future, as in the past, large shipments will be made directly from the company's factories in East Newark.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

Lake Shore & Michigan Southern Railway.

V.

THE MACHINE TOOL EQUIPMENT.

POWER FOR THE TOOLS.

When the design of the machine tool equipment and lay-out for the machine shops at Collinwood was under consideration a great deal of difficulty was occasioned by the general scarcity of information and data available regarding the powering of most kinds of machine tools, and the best methods of driving them. A large amount of study was necessary to perfect these details and to arrive at the best possible solutions of the questions, particularly as there was at the time very little precedent to follow.

Probably the most important question was the powering of the tools. A large amount of very valuable data was gathered on this subject during the original investigations, in connection with the determination of the generator capacity necessary to be installed in the central power plant to operate the entire power system. The power that would be required to run each of the machine tools to be installed at the shops was carefully estimated from the best of the data obtainable, for the purpose of first determining as nearly as possible the proper sizes of motors for running them. These estimated power inputs were based upon the full-load capacities of the respective tools—a value which is rather indefinite with most machine tools, being dependent usually upon the product of the size of the heaviest cut and the highest cutting speed, or, in other words, upon the highest rate of removal of metal. The estimated required powers for each tool installed appear, as adopted, in the accompanying tool list presented on pages 42 and 43. It is to be noted that in the list of direct-connected tools these estimated powers appear in the left-hand column, the outside column to the extreme right indicating the sizes of motors actually applied finally to each of the tools.

The direct-connected tools are equipped with motors of capacities anywhere from 60 to 300 per cent. of their estimated required powers, according to the tool and to the work for which they were to be used. This difference is caused by the excess of powering required by the multiple-voltage system, as will be afterwards explained, and also in some cases by the expectation of a slightly greater power to be required than previously estimated.

Such tools as planers, shapers, grinders, blowers, etc., which require their full power continuously when in operation are quipped with motors of exactly 100 per cent. of their maximum powers. In the cases of the smaller machine tools which are group-driven from line-shafting, each group is driven by a ceiling-type line-shaft motor of a capacity equal to something less than the sum of the maximum powers of all the tools in the group, the desired percentage of power in the motor being 75 per cent.; this percentage was not adhered to, however, for practical reasons. The majority of the groups were equipped with motors of larger sizes than had been estimated as necessary in order to provide in advance for extensions. Some of the groups are powered as high as 140 per cent. and 160 per cent. of their present required power.

The method of arriving at the generator capacity necessary in the power plant to take care of the machine shop motors is interesting. The motors which are direct-connected to machine tools, operating with variable loads, were estimated to require about 30 per cent. of the rated horse power of the tool, the transmission loss being estimated at 20 per cent.; this made the power actually required about 36 per cent. of the total power. The constant-load tools, such as the planers, blowers, etc., were figured at 100 per cent. of their full powers, with a 20 per cent. allowance for transmission losses. The group-driven tools were estimated to require, at their motor, about 50 per cent. of the power that would be required to run all the tools of the group at full load, this figure including all losses in transmission, both electrical and mechanical. The total crane, turntable, transfer table and elevator load that the power plant generators will be called upon to carry was estimated flatly at 75 kilowatts, a quantity based upon experience at other plants; it is more than probable that, with the generous overload capacity that is provided in the generators, no combination of circumstances will ever arise to cause a sufficient overload from the cranes to seriously affect them.

GENERATOR CAPACITY REQUIRED.

It is interesting to note in this connection the relation of the total generator capacity arranged for in the power plant to the total power actually required by the various departments of the shop for both lighting and machine driving. As will be recalled from the description of the power plant in our November, 1902, issue, the capacities of the generators installed are 400-kw., 400-kw. and 75-kw., making a total capacity of 875 kw. (1,167 h.p.). These machines are all designed to easily withstand overloads of 25 per cent., and will even carry overloads of 75 per cent. momentarily without serious inconvenience; thus the power plant can easily take care of a steady overload of 1,094 kw. (1,460 h.p.), and may withstand momentarily a load as high as 1,532 kw. (2,043 h.p.). The power that will be demanded for lighting and machine driving in the various departments of the shops is given in the table appended below, subdivided into constant loads, variable loads, cranes and lighting:

ESTIMATE OF POWER REQUIRED AT COLLINWOOD SHOPS.

A.—For Machine-Tool Driving—Constant Load:
(Estimated—Load factor, 100 per cent.; transmission efficiency, 80 per cent.)

Locomotive shops building	45 H. P.	42.2 Kw.	
Blacksmith shop building	60 H. P.	56.2 Kw.	
Car shops buildings	100 H. P.	93.7 Kw.	
Total	205 H. P.		192.1 Kw.

B.—For Machine-Tool Driving—Variable Loads:
(Estimated—Load factor, 30 per cent.; transmission efficiency, 80 per cent.)

Locomotive shops building	715.3 H. P.	201.1 Kw.	
Blacksmith shop building	363.0 H. P.	102.1 Kw.	
Car shops buildings	451.5 H. P.	127.0 Kw.	
Power plant (coal crusher, etc.)	27.5 H. P.	7.7 Kw.	
Total	1,557.3 H. P.		437.9 Kw

C.—For Cranes, Transfer Tables, Etc:	Power Estimated.	
100-ton erecting shop traveling crane	30 Kw.	
30-ton boiler shop traveling crane	10 Kw.	
7½ and 10-ton locomotive shops cranes	5 Kw.	
Turntables, 72 ft. (roundhouse and loco. shops)	5 Kw.	
Transfer tables, 75 ft. (two for car shops)	10 Kw.	
Elevator (5,000-lb. electric for storehouse)	2 Kw.	
Total		62.0 Kw.

D.—For Electric Lighting—All-Night Load:
(Estimated—Load factor and transmission efficiency, 100 per cent. total.)

	Arcs.	Incand'ts.		
Shops and shop yard	33	152	27.4 Kw.	
Roundhouse and yard	6	274	17.3 Kw.	
Transportation department	45	60	30.0 Kw.	
Total	84	486		74.7 Kw.

LIST OF TOOLS AND MOTORS.

Collinwood Shops.—Lake Shore & Michigan Southern Railway.

LOCOMOTIVE DEPARTMENT, DIRECT-CONNECTED TOOLS.

No.	Tool.	Maker.	H. P. Required.	H. P. of Motor Applied.
	TESTING LABORATORY.			
83	20,000-lb. testing machine	Riehle Bros.	...	7.5
	MACHINE SHOP.			
8	84-in. boring mill	Niles Tool Works Co.	3.5	M.V., 10
9	51-in. boring mill	Niles Tool Works Co.	3.5	M.V., 7.5
10	84-in. driving wheel lathe	Niles Tool Works Co.	8	M.V., 15
11	84-in. driving wheel lathe	Niles Tool Works Co.	8	M.V., 15
12	Driving wheel quartering machine	Niles Tool Works Co.	6	5—5
14	Frame slotting machine	Bement-Miles & Co.	20	M.V., 20
15	54-in. x 54-in. x 32-ft. frame planer	Pond Machine Tool Co.	20	20
16	Locomotive rod boring machine	Niles Tool Works Co.	6	M.V., 5
17	36-in. x 36-in. x 10-ft. planer	Pond Machine Tool Co.	7.5	M.V., 7.5
18	60-in. horizontal boring machine	Niles Tool Works Co.	2.5	M.V., 5
19	24-in. gearer slotter	Niles Tool Works Co.	8.7	M.V., 7.5
20	No. 3 vertical spindle milling machine	Newton Machine Tool Co.	7.5	M.V., 10
21	No. 4 special plain milling machine	Newton Machine Tool Co.	7.5	M.V., 10
30	84-in. driving wheel lathe	Niles Tool Works Co.	8	M.V., 15
31	28-in. x 12-ft. 6-in. bed engine lathe	Pond Machine Tool Co.	3.5	M.V., 7.5
32	28-in. x 12-ft. 6-in. bed engine lathe	Pond Machine Tool Co.	3.5	M.V., 7.5
33	32-inch x 16-ft. bed engine lathe	Pond Machine Tool Co.	3.5	M.V., 7.5
34	36-in. triple geared engine lathe	Pond Machine Tool Co.	5	M.V., 7.5
35	28-in.—48-in. extension gap lathe	Edw. Harrington Son & Co.	3.5	M.V., 7.5
36	42-in. x 16-ft. triple geared engine lathe	Pond (Old Tool)	5	M.V., 10
37	42-in. x 42-in. x 10-ft. planer	Niles (Old Tool)	12	10
38	No. 2 6-ft. radial drill	Niles Tool Works Co.	5	3
39	88-in. hydrostatic wheel press, 300-ton	Elkhart Shops (Old Tool)	10	10
40	Driving axle lathe	Niles (Old Tool)	5	M.V., 10
41	48-in. hydrostatic wheel press, 150-ton	Niles Tool Works Co.	7.5	M.V., 10
42	48-in. radial drill	Prentice Bros. Co.	5	3
44	36-in. x 36-in. x 8-ft. open side planer	Detrich & Harvey Machine Co.	10	10
45	38-in. x 38-in. x 10-ft. planer	Niles (Old Tool)	10	7.5
46	42-in. x 42-in. x 12-ft. planer	G. A. Gray & Co.	12	M.V., 15
47	No. 4 plain milling machine	Newton Machine Tool Co.	7.5	M.V., 10
48	60-in. horizontal boring machine	Niles Tool Works	2.5	M.V., 5
49	84-in. boring mill	Niles Tool Works	3.5	M.V., 10
50	28-in. x 12-ft. 6-in. engine lathe	Pond Machine Tool Co.	3.5	M.V., 7.5
51	30-in. x 16-ft. engine lathe	Pond (Old Tool)	3.5	M.V., 7.5
52	36-in. x 16-ft. engine lathe	Pond (Old Tool)	5	M.V., 7.5
53	42-in. x 18-ft. triple geared engine lathe	Pond Machine Tool Co.	5	M.V., 10
54	36-in.—60-in. extension gap lathe	Edw. Harrington Son & Co.	5	M.V., 7.5
70	42-in. car wheel lathe	Pond Machine Tool Co.	9	M.V., 20
71	37-in. boring mill	Bullard Machine Tool Co.	3.5	5
72	37-in. boring mill	Bullard Machine Tool Co.	3.5	5
73	Portable cylinder boring machine	Bullard (Old Tool)	1	
76	Arbor driven cold saw	Q. & C. Ry. Supply Co.	3.5	7.5
77	42-in. car wheel boring machine	Putnam Machine Co.	3.5	7.5
78	Double car axle lathe	Putnam Machine Co.	7.5	M.V., 15
79	16-in. slotting machine	Niles Tool Works Co.	4.5	M.V., 10
82	26-in. triple geared shaper	Cincinnati Shaper Co.	3	3
89	Gardner disc grinder	C. H. Besly & Co.	5	5
90	18-in. x 2-in. emery grinder	C. H. Besly & Co.	3	
94	45-in. smoke exhauster fan	Buffalo Forge Co.	15	15
	BOILER SHOP.			
22	Single No. 2 punch	Long & Allstatter Co.	5.5	5
23	Single No. 2 shear	Long & Allstatter Co.	5.5	5
24	12-ft. 2-in. x 7/8-in. bending rolls	Bement-Miles Co.	30	{ 15; M.V., 20
25	No. 3 plate straightening rolls	Niles Tool Works Co.	7.5	M.V., 10
28	3/4-in. single No. 4 punch	Long & Allstatter Co.	3	3
29	Single No. 4 shear	Long & Allstatter Co.	3	3
43	No. 2 bevel rotary shear	Lenox Machine Co.	7.5	M.V., 10
55	9-in. horizontal flange punch	Niles (Old Tool)	5.5	5
56	Four-spindle multiple drill	Niles Tool Works Co.	8	7.5
57	36-in. throat multiple punch	Cincinnati Punch & Sh. Wks Co.	7.5	7.5
80	No. 2 6-ft radial drill	Niles (Old Tool)	5	
84	No. 2 plate bending roll	Hilles & Jones	10	M.V., 10
85	Flue rattler	Elkhart Shops	12	
98	No. 6 pressure blower, flue furnace	Buffalo Forge Co.	6	6.5
99	No. 6 pressure blower, flange furnace	Buffalo Forge Co.	6	6.5
	BLACKSMITH SHOP.			
67	No. 6 bulldozer	Williams & White	15	20
68	No. 8 bulldozer	Williams & White	25	25
69	3½-in. forging machine	Blakeslee	10	
86	Combined punch and shear		5	
87	Bar shear	Hilles & Jones	10	15
96	No. 7 pressure blower, bulldozers	Buffalo Forge Co.	9	9.5
97	No. 6 pressure blower, spring shop	Buffalo Forge Co.	6	6.5
100	No. ½ blower case hardening furnace	Root		

BOLT SHOP.

No.	Tool.	Maker.	H. P. Required.	H. P. of Motor Applied.
74	No. 3 3-in. bar shear	Cincinnati Punch & Sh. Wks Co.	5	10
95	No. 6 pressure blower	Buffalo Forge Co.	6	6.5

SCRAP PLATFORM.

No.	Tool.	Maker.	H. P. Required.	H. P. of Motor Applied.
88	Scrap shear		10	

LOCOMOTIVE DEPARTMENT—GROUP DRIVEN TOOLS.

No.	Tool.	Maker.	H. P. Required per Machine.
	GROUP A. MACHINE SHOP, GRINDING ROOM—DRIVEN BY A 25 H. P. MOTOR.		
218	Buffing and polishing wheel 30-in x 8-in.	Elkhart Shop	15
219	Buffing and polishing wheel 30-in. x 8-in.	Elkhart Shop	15
		Total	30
	GROUP B. MACHINE SHOP, GRINDING ROOM—DRIVEN BY A 25 H. P. MOTOR.		
216	Grindstone 84-in. x 16-in.	Manning, Maxwell & Moore	15
217	Grindstone 84-in. x 16-in.	Manning, Maxwell & Moore	15
		Total	30
	GROUP C. MACHINE SHOP, ROD DEPARTMENT—DRIVEN BY A 25 H. P. MOTOR.		
116	Two-spindle Whiton centering machine	U. Baird Machine Co.	.8
121	Sensitive drill No. 4	Barr Mfg. Co.	.5
124	21-in. Standard drill press	Prentice Bros. Co.	.75
133	32-in. Standard drill press	Niles Tool Works Co.	2
136	32-in. Standard drill press	Niles Tool Works Co.	2
151	26-in. triple geared shaper	Cincinnati Shaper Co.	2.5
157	16-in. slotting machine	Niles Tool Works Co.	3
168	16-in x 6-ft. engine lathe	Prentice Bros. Co.	1
170	16-in x 8-ft. engine lathe	Prentice Bros. Co.	1
180	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
183	24-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
211	No. 2 swinging grind. and polish. mach.	Niles Tool Works Co.	3
213	No. 2 plain milling machine	Newton Machine Co.	3
224	Oscillating surface grinder	Springfield Mfg. Co.	4
		Total	27.55
	GROUP D. MACHINE SHOP, MOTION WORK DEPARTMENT—DRIVEN BY A 10 H.P. MOTOR.		
129	30-in. Standard drill press	Prentice Bros. Co.	1
130	32-in. Standard drill press	Niles Tool Works Co.	2
134	32-in. Standard drill press	Niles Tool Works Co.	2
154	20-in. x 50-in. open side shaper & planer	Richards (Old Tool)	3
172	16-in. x 8-ft. engine lathe	Prentice Bros. Co.	1
175	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
179	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
220	Link grinder	L. C. Hammett & Co.	3
		Total	16
	GROUP E. MACHINE SHOP, GENERAL WORK—DRIVEN BY A 15 H. P. MOTOR.		
152	26-in. triple geared shaper	Niles (Old Tool)	2.5
153	20-in. x 50-in. open side shaper & planer	Walker Mfg. Co.	3
156	16-in. slotting machine	Niles Tool Works Co.	3
160	No. 4 Universal milling machine	Brown & Sharp Mfg. Co.	3
177	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
178	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
206	No. 2 Keyseat driller	Bement-Miles & Co.	1
230	18-in. x 96-in. plain grinder	Norton Grinding Co.	5
		Total	21.5
	GROUP F. MACHINE SHOP, TOOL DEPARTMENT—DRIVEN BY A 20 H. P. MOTOR.		
117	Bench drill	(Old Tool)	.5
119	Sensitive drill No. 4	Barr Mfg. Co.	.5
126	21-in. drill press	Prentice Bros. Co.	.75
127	24-in. drill press	Prentice Bros. Co.	1
138	Universal tool grinder	Wm. Sellers & Co.	4
139	No. 3 Universal grinder	Brown & Sharp Mfg. Co.	3
141	Reamer grinder	(Old Tool)	1
155	15-in. shaper	Hendey Machine Co.	3
159	No. 3 Universal milling machine	Brown & Sharp Mfg. Co.	2
161	14-in. x 6-ft. tool room lathe	Pratt & Whitney	1
162	14-in. x 6-ft. tool room lathe	Pratt & Whitney	1
163	14-in. x 8-ft. tool room lathe	Pratt & Whitney	1
174	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
222	Walker cutter grinder	Norton Emery Wheel Co.	3
		Total	23.75

E.—For Electric Lighting—Occasional, Day Load:
(Estimated—Load factor and transmission efficiency, 75 per cent. total.)

	Arcs.	Incand'ts.	
Shops and shop yard......	249	1,136	154.6 Kw.
Roundhouse and yard..........			
Transportation dept. yard.. ..		12	.4 Kw.
Total	249	1,148	155.0 Kw.

(Arc lamps estimated as requiring 600 watts each and incandescent lamps as requiring 50 watts each.)

Grand total ....921.7 Kw.

This figure, 921.7 kilowatts (1,228.9 h.p.), which is the total *expected* power that will be demanded from the power plant under ordinary conditions of operation, is only about 5 per cent. more than the total rated full-load capacities of the generators, being well within their 25 per cent. overload capacity. The probable load that will be demanded will undoubtedly be within the combined capacity of the two larger 400-kw. generators, which can easily carry for their 25 per cent. overload capacity a steady load of 1,000 kw. (1,333.3 h.p.), so that the smaller 75-kw. dynamo may be held for reserve and for night service. The greatest possible total load that could be brought upon the power plant, by a simultaneous starting at full load of all the current-consuming devices upon the power and lighting systems, is about 1,880 kw. (2,507 h.p.), but this is a totally improbable and almost impossible combination.

METHOD OF APPLYING MOTOR DRIVES.

Neither the individual motor-drive nor the group-drive system was given absolute preference in the applications of electric motors for driving machine tools at the Collinwood shops. Individual direct-connected motors were installed on about three-eighths of the machine tools, while the remainder of the entire equipment was arranged for group driving from line-shafting, there being 17 groups, each having its line-shaft driven by a separate constant-speed motor. Rather than the method of driving by individual direct-connected motors hav-

GROUP G. MACHINE SHOP, BRASS DEPARTMENT—DRIVEN BY A 25 H. P. MOTOR.

No.	Tool.	Maker.	H. P. Required. Per Machine.
118	Bench drill	(Old Tool)	.5
120	Sensitive drill No. 4	Barr Mfg. Co.	.5
128	24-in. Standard drill press	Niles Tool Works Co.	2
140	Cock grinder	Warner & Swasey	1
158	Two-spindle valve milling machine	Warner & Swasey	2
167	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
173	21in. x 10-ft. engine lathe with tapering attachment	Prentice Bros. Co.	2
182	24-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
185	27-in. x 10-ft. engine lathe with tapering attachment	Ed E. Reed Co.	2
187	No. 2 cabinet lathe	American Tool & Machine Co (Old Tool)	.75
188	16-in. geared friction head forming monitor lathe	Warner & Swasey	2.5
189	16-in. geared friction head forming monitor lathe	Warner & Swasey	2.5
202	No. 2 cabinet turret lathe	American (Old Tool)	.75
209	No. 2 cabinet lathe	American	.75
210	No. 2 cabinet lathe	American	.75
		Total	21.

GROUP H. MACHINE SHOP, BOLT DEPARTMENT—DRIVEN BY A 25 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
115	Two-spindle Whiton centering machine	U. Baird Machine Co.	.8
144	No. 4 turret bolt cutter	Pratt & Whitney	2
145	1½-in. double head bolt cutter	Acme Machinery Co (Old Tool)	2.5
148	1½-in. nut facing machine	Acme Machinery Co.	2.5
149	2½-in. nut facing machine	Acme Machinery Co.	2.5
150	Automatic screw machine	Cleveland Machine Screw Co.	2.5
164	16-in. x 6-ft. engine lathe with tapering attachment	Prentice Bros. Co.	1
165	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
166	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
169	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
190	2-in. x 24-in. turret lathe	Jones & Lampson (Old Tool)	3
191	Hollow hexagon turret lathe	Warner & Swasey	3
192	Hollow hexagon turret lathe	Warner & Swasey	3
193	Hollow hexagon turret lathe	Warner & Swasey	3
204	Four-spindle staybolt cutter	Acme Machinery Co.	5
221	Two-spindle staybolt cutter	Acme Machinery Co.	3
		Total	36.8

GROUP I. BOILER SHOP, FLUE DEPARTMENT—DRIVEN BY A 10 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
195	Flue welding machine	Hartz	3
196	Flue welding machine	Hartz	3
		Total	6

GROUP J. MACHINE SHOP, GENERAL WORK—DRIVEN BY A 10 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
114	37-in. boring mill	Niles Tool Works Co.	3.5
122	Two-spindle sensitive drill	Foote & Burt	.5
137	No. 5 drill	Niles (Old Tool)	3
146	2½-in. bolt cutter and nut tapper	Acme Machinery Co.	2.5
147	2-in. six-spindle nut tapper	Acme Machinery Co.	2.5
176	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
181	24-in. x 10-ft. engine lathe with tapering attachment	Ed E. Reed Co.	2
186	27-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
		Total	18

GROUP K. MACHINE SHOP, AIR PUMP DEPARTMENT—DRIVEN BY A 15 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
123	Two-spindle sensitive drill	Foote & Burt	.5
131	32-in. Standard drill press	Niles Tool Works Co.	2
171	16-in. x 8-ft. engine lathe with tapering attachment	Prentice Bros. Co.	1
184	24-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
201	16-in. back geared shaper	Cincinnati Shaper Co.	3
212	42-in. power squaring shears	Manning, Maxwell & Moore	1
214	6-in. pipe cutting machine	Jarecki Mfg. Co.	4
215	3-in. pipe cutting machine	Jarecki Mfg. Co.	2
		Total	15.5

GROUP L. MACHINE SHOP, GENERAL WORK—DRIVEN BY A 7.5 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
125	21-in. Standard drill press	Niles Tool Works Co.	1.5
132	32-in. Standard drill press	Niles Tool Works Co.	2
135	32-in. Standard drill press	Niles Tool Works Co.	2
		Total	5.5

GROUP M. BLACKSMITH SHOP—DRIVEN BY A 50 H. P. MOTOR.

No.	Tool.	Maker.	H. P. Required. Per Machine.
101	No. 11 volume blower	Buffalo Forge Co.	32
102	110-in. steel plate exhauster	Buffalo Forge Co.	23
		Total	55

GROUP N. BLACKSMITH SHOP, BOLT SHOP—DRIVEN BY A 20 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
231	1½-in. bolt header	Acme Machinery Co.	5.5
232	1½-in. bolt header	Acme (Old Tool)	5.5
233	2½-in. forging machine	Ajax (Old Tool)	7.5
234	1½-in. bolt header	Acme Machinery Co.	5.5
		Total	24

GROUP O. BLACKSMITH SHOP, BOLT SHOP—DRIVEN BY A 15 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
237	2-in. triple head bolt cutter	Acme Machinery Co.	3
238	1½-in. triple head bolt cutter	Acme Machinery Co.	3
239	1½-in. triple head bolt cutter	Acme Machinery Co.	3
240	2½-in. double head bolt cutter	Acme Machinery Co.	3
241	Six-spindle nut tapper	Acme Machinery Co.	3
242	Six-spindle nut tapper	Acme Machinery Co.	3
		Total	18

GROUP P. BLACKSMITH SHOP, SPRING DEPARTMENT—DRIVEN BY A 15 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
197	Large tapering rolls	John Evans' Sons	4
198	Combined nipper and trimmer machine	John Evans' Sons	4
199	Combined punch and shear	John Evans' Sons	4
		Total	12

GROUP Q. BLACKSMITH SHOP, HAMMERS—DRIVEN BY A 20 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
109	200-lb. compact hammer	Bradley & Co.	8
110	200-lb. compact hammer	Bradley & Co.	8
111	200-lb. compact hammer	Bradley & Co.	8
112	200-lb. compact hammer	Bradley & Co.	8
113	50-lb. compact hammer	Bradley & Co.	5
		Total	37

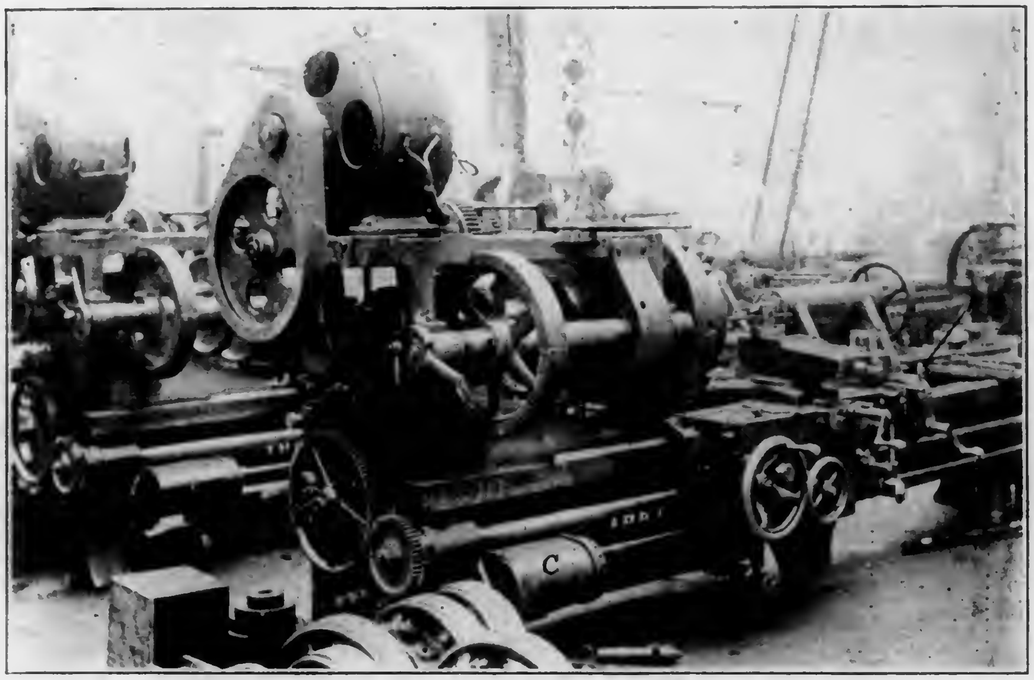
ing been considered the ideal condition to be resorted to exclusively, group-driving appears to have received the preference, inasmuch as tools were arranged for an individual drive only when the advantages to be gained thereby over a drive from line-shafting were of considerable weight.

One of the most important considerations favoring the application of individual direct-connected motors was that of the locations of the tools. It was very desirable and practically necessary that this method of driving be applied to all tools located in the portions of the shops served by traveling cranes, in order to prevent the interference that would otherwise be caused by belting, countershafting, etc., and also where the tools are scattered and isolated, as they are in the boiler shop, it was found to be cheapest and by far most convenient to apply individual drives. The latter is particularly evident when the losses of power that would have occurred in the necessarily long stretches of line-shafting are considered, and, moreover, because in the boiler shop it would practically have been necessary to have used one motor to each tool even if line-shafting had been used.

In general it may be said that the policy adhered to in the installation was that individual motor drives were applied to all machine tools which were of sufficient size so that the extra expense would be justified on account of the advantages to be gained from the variable speeds possible with them on the multiple-voltage system. It was thought desirable that machine tools requiring 5 horse-power, or over, should be so equipped to take advantage of the multiple-voltage system; this was done on all the larger machines with the exception of the quartering machine, some of the planers and shapers, and some of the boring mills, drills, grinders, etc. (tools Nos. 12, 15, 37, 38, 39, 42, 44, 45, 71, 72, 76, 82, 89 and 90—see tool list), which are individually driven by constant-speed motors on account of not requiring the variable speeds. The car wheel boring machine (tool No. 77) will probably be changed over for a multiple-voltage drive. The above-mentioned tools, equipped with constant speed motors, might have been group-driven from line-shafting, but for the fact that they are located in the heavy tool section of the machine shop, which has a traveling crane service. The tools that are individually driven by variable-speed motors include the heavier lathes (28-in. and over), the larger boring mills, the horizontal boring machine, the larger planers, frame slotter, wheel lathes, etc.

THE INDIVIDUAL MOTOR DRIVES.

In the application of the individual motor drives to the machine tools it was necessary to carefully consider not only the adaptation of the tool to the drive, but the electrical questions as well, including the method of speed control, the ranges of speed, etc., which were of great importance on account of their effect upon the former problem. As previously stated, the Crocker-Wheeler system of multiple-voltage speed control was, after a careful investigation of the various variable-speed systems, adopted and the necessary generating equipment for the four voltages installed as a part of the power plant equipment. The critical point which determines the practicability of this system is, however, the extent of the range of speeds to be made use of with the motors; because with too wide a range of speeds the sizes of the motors necessary become so large as to render the system too expensive and very inconvenient of application.



28-INCH TRIPLE GEARED ENGINE LATHE—POND MACHINE TOOL CO. DRIVEN BY 7½ H.P. MULTIPLE VOLTAGE CROCKER-WHEELER MOTOR. COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The multiple-voltage system permits of ranges of speed as wide as 6 to 1, and even up to 10 to 1; but if it were desired, with the wider ranges, to have the motors exert the same power at the lowest speeds as they would be required to with the highest speeds, they would necessarily have to be several sizes larger than necessary if only the higher speeds were to be used. This is due to the basic principle of the operation of dynamo-electrical machinery—that the capacity is almost exactly proportional to the speed at which the machine operates; so that the slower a motor runs the less is the power delivered with safety. If a motor on the multiple-voltage system be designed for the maximum power required with its slowest speed, then in delivering the same amount of power at speeds six or ten times greater it would be working at only one-sixth or one-tenth of its capacity, or, in other words, at the highest speeds the motor would be six or ten times too large. The objections to operating an electric motor at full load at one sixth or one-tenth of its full load capacity are its extremely low efficiency in the use of power at small loads, and the me-

conveniences (mechanical) resulting from the use of a machine many times too large, such as difficulty of supporting the extra weight, vibration and momentum of the heavier rotating parts, etc., as well as the greater expense of installing a large equipment.

In view of these objections to the wide speed range, a small range of speed variation, namely, 2.4:1, was adopted for the motors; this removes almost entirely the objections to the wider ranges by permitting the use of motors from one-half to one-third of the sizes that would have been required to obtain full power through the 6 to 1 or 10 to 1 ranges, and, still, the possibility of using the motors through ranges of 6:1 or 10:1, when on light work, is retained. At the same time, all the advantages of the wider ranges have been retained by the applications of "back gear" attachments in the motors' drives, which multiply as many times as necessary the speed range at full power obtained from the motor.

In many cases these runs of gearing have been so chosen that the actual ranges of speeds possible at the tool are from 50 to 1, or even 100 to 1. On the individually-driven lathes three changes of gearing are provided in all, in addition to the lathe's back gears, while on the boring mills two changes were found to be sufficient.

The adaptations of the tools to the conditions imposed by the electric drives were left mainly to the tool builders themselves to decide, as a result of which there are, on different tools, several different methods in use for attaining the desired results. In nearly every case the motor has been mounted on brackets attached to the frame of the machine, and connected to the driving mechanism through as many alternative trains of gearing as the case has required. The method of connecting through any desired one of these trains varies; in a number of cases it is done by sliding change-gears in aud out of mesh along a splined shaft, in other cases the different gears are picked up by means of clutches, while in still others sliding keys or drop keys are used. Also in some cases the operation of changing the gear ratios is made convenient and simple by levers so arranged as to connect up the different series by the positions to which it is moved; an example of this appears in the 16-in. Niles slotter illustrated on page 47. These, as well as the types of brackets and framing, illustrate the ideas of the different tool builders, and experience only will indicate the advantages of the several methods and point out the direction of possible improvements.

The controlling devices have, in some cases, been mounted on stands attached to the floor and near the workman's hand. On the lathes the controllers are mounted on the bed underneath the headstock, and are operated through mechanical connections by a handle attached to the lathe carriage, and therefore always convenient at whatever point along the bed the tools may be working. The convenience of control thus obtained lends itself in the highest degree to self-education on the part of the workman in obtaining, at all times, that cutting speed which will give the best results with each particular piece of work, and so tends to increase of output.

In the determinations of the correct ratios of the various change gears for the back gear attachments to be applied to the machine tools, a diagram showing the relation of cutting speeds to diameters of work was plotted for each tool; the diameters of work were laid off as ordinates and the cutting speeds as abscissæ. Then vector lines, laid off on these diagrams corresponding to numbers of revolutions of the spindles, present graphically the relations between the cutting speeds and the diameters of work for those spindle speeds. Examples of such initial diagrams for the 84-in. Niles driving wheel lathes and the 28-in. Pond engine lathes are presented on page 46. As may be seen, the spindle speed for each vector is named upon it in rev. per min., the smaller number of full lines indicating the various spindle speeds possible with belt drives and cone pulleys, while the dotted lines indicate the greater range of speeds available with the multiple-voltage system.

Where the variation in the number of revolutions at the spindle of a tool required to give the correct cutting speed over the range of diameters of work to be handled does not exceed 2.4 to 1 no change gears are necessary, as that variation can be taken care of by the multiple-voltage system of control and the full 6:1, or 10:1, range at reduced power can be used for variations in cutting speed only.

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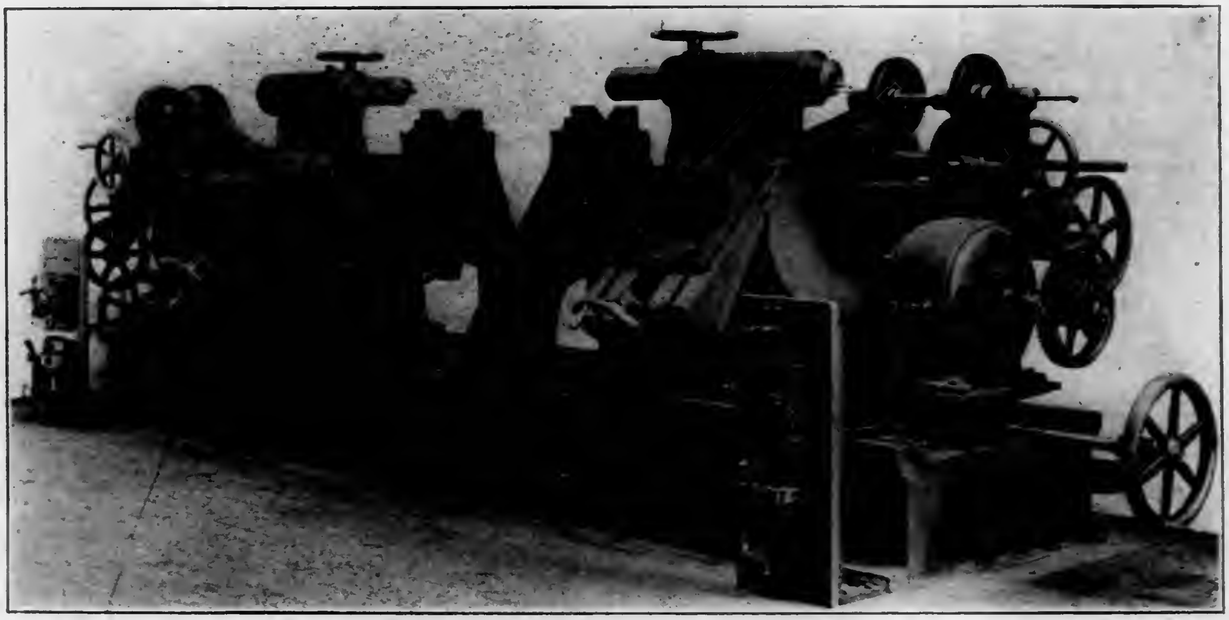

84-INCH QUARTERING MACHINE.—NILES TOOL WORKS CO.
EACH HEAD DRIVEN BY A 5-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

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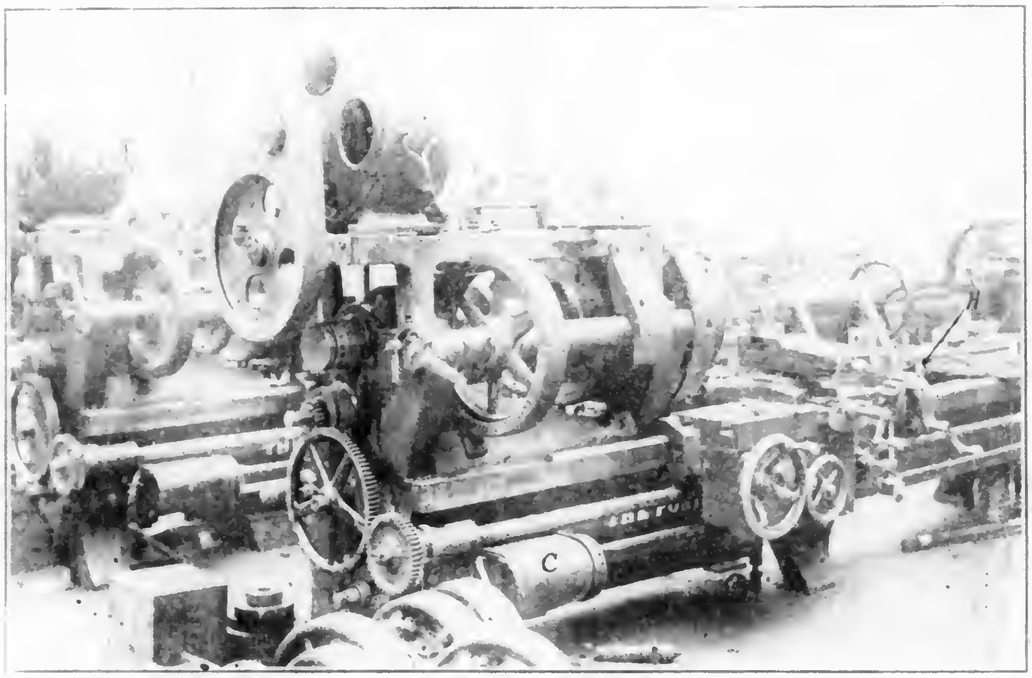

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COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

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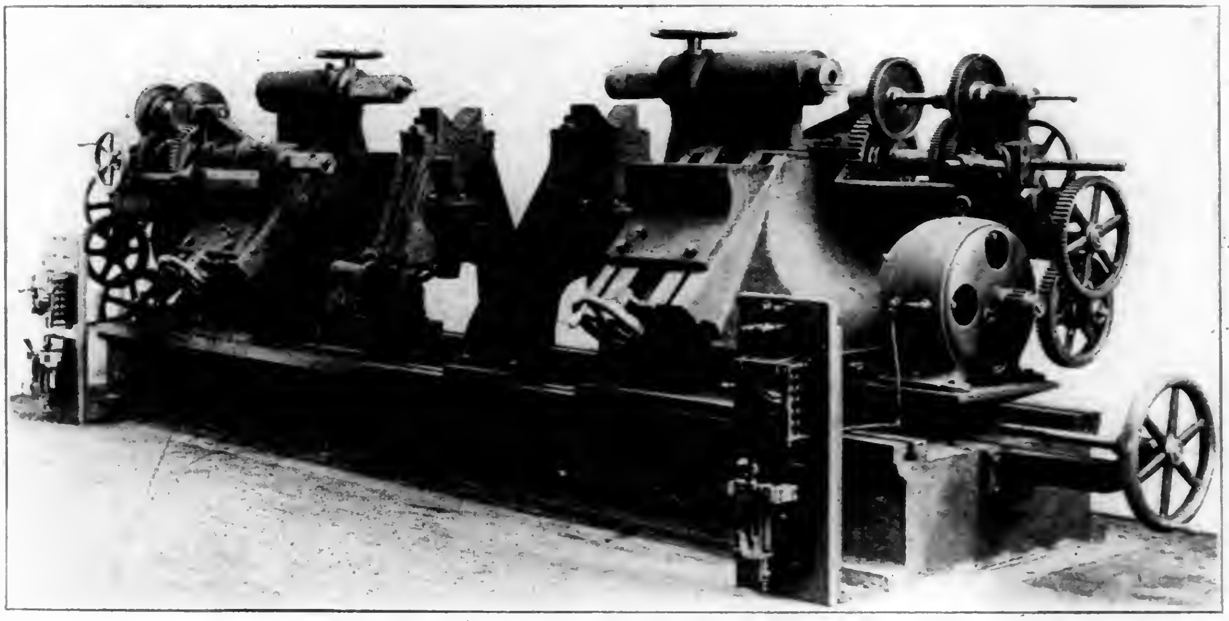

84-INCH QUARTERING MACHINE.—NILES TOOL WORKS CO.
EACH HEAD DRIVEN BY A 5-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY

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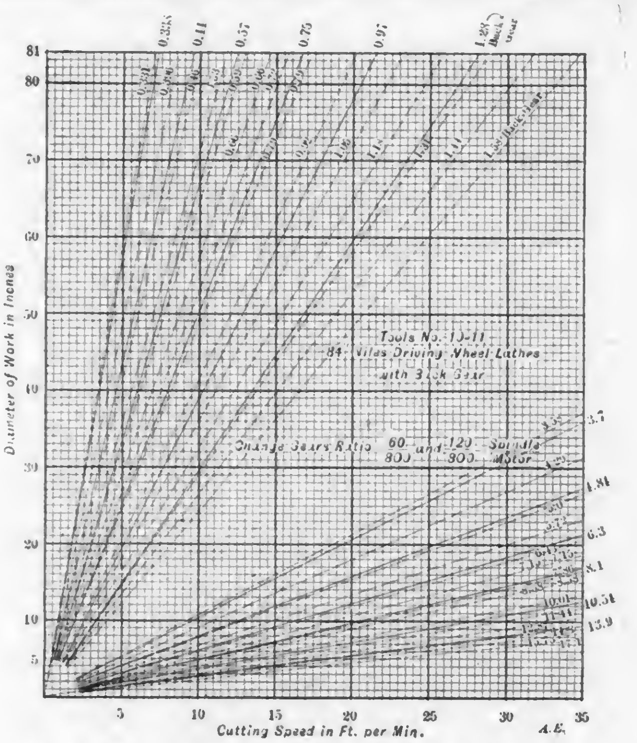
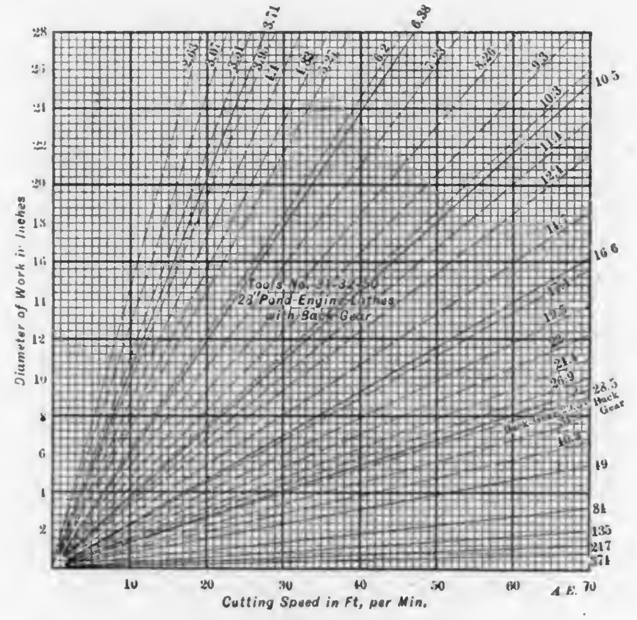
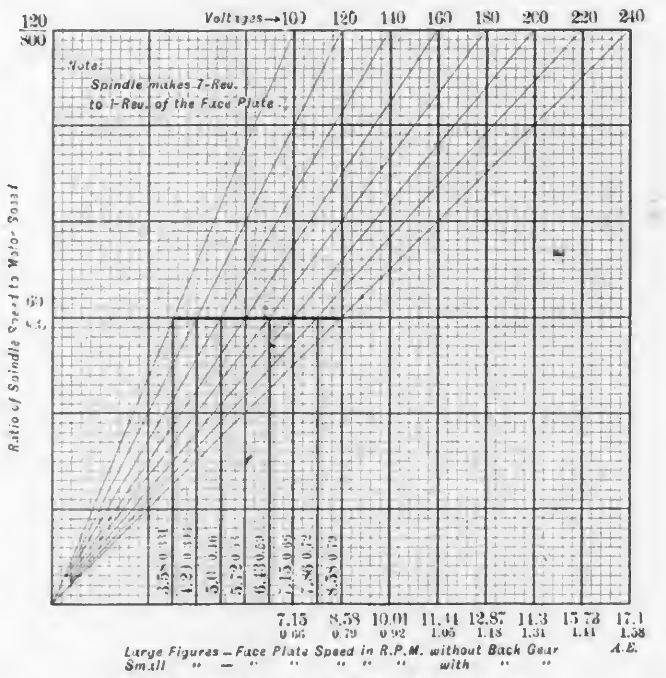


84-INCH NILES DRIVING-WHEEL LATHES WITH BACK GEARS.

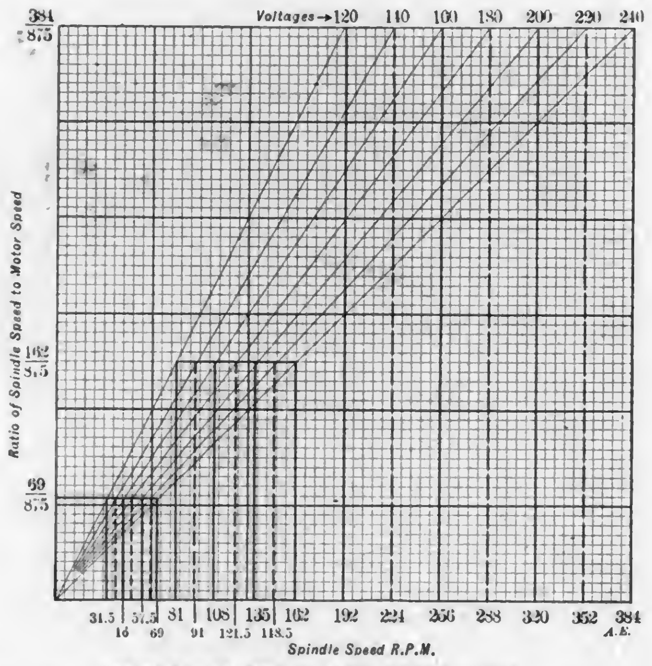


28-INCH POND ENGINE LATHES WITH BACK GEARS.



GEAR RATIOS, 84-INCH NILES WHEEL LATHE.

H.P. Required to Drive	8	
Proposed Motor	15	H.P.
Motor overloaded 25 per cent	= 18.75	H.P.



GEAR RATIOS, 28-INCH POND ENGINE LATHE.

H.P. Required to Drive	3.5	
Proposed Motor	7.5	H.P.
Motor overloaded 25 per cent	= 9.375	H.P.

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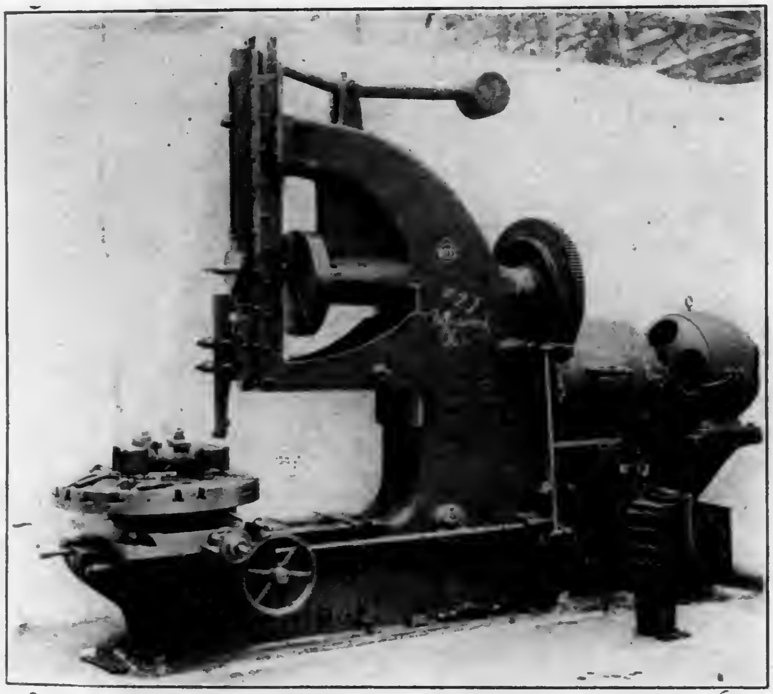
motor-driven lathe presents advanced ideas of electric driving, the motor being mounted directly upon framework above the headstock and gear connected to the drive. This lathe is a 28-in. triple-geared lathe built by the Pond Machine Tool Company, Plainfield, N. J., and specially adapted for the motor, which is a 7½ h.-p. Crocker-Wheeler multipolar motor. Twelve different speeds are available from the multiple voltage system and by means of gearing and clutches three gear ratios are possible, making a wide range of 36 speeds possible. The most remarkable feature of the electrical application is the location of the controller, as shown at C, so that it can be at all times manipulated from the carriage by handle, H, through the agency of a splined shaft parallel to the lead screw.

This lathe has a bed 10½ ft. long, and will take work, swinging 29½ ins. over the bed, or 22 ins. over the carriage, 4 ft. between centers. The bed is heavy and wide enough to prevent overhang of carriage at the front when turning on the largest diameters. The carriage has long bearings upon the ways, is gibbed down to the bed for stability and can be clamped rigid when cross-feeding. A desirable feature is that when either of the feeds or the screw-cutting attachment of the carriage is in use the others are all locked.

The slotting machine shown above is a 16-in. crank-motion slotter direct driven by a motor through the medium of gearing and clutches. The clutches control the various gear ratios for the drive, which may be changed from one to another by means of the handle projecting from the gear case. This slotter has a crank-driven ram and is equipped with a Whitworth quick-return motion. The feeds are actuated by a large cam on the main gear, and always take place at the top of the stroke. This machine has a 36-in. table, with a 36-in. longitudinal and 24-in. cross-feed, and has a circular feed. The maximum height of the ram above the table is 19 ins. The extremely convenient location of the controller and circuit breaker is made evident in the engraving.

The 84-in. Niles quartering machine, illustrated on page 45, has two constant-speed drives, each Crocker-Wheeler 5 h.-p. multipolar motors, one of which is located at each head of the machine, entirely independent of the other. Each motor has its controller and circuit breaker located conveniently on a stand in front of it. This machine will quarter wheels from 45 to 84 ins. in diameter for crank radii of from 8 to 16 ins. The boring spindles may be changed to either side of their heads at will for boring right or left-hand leads. The steady rests between the heads are to carry the weight of the wheels, the centering spindles acting merely to assist in locating them.

The remaining engravings on this page illustrate the application of the motor drive to a 200-ton, 48-in. hydrostatic wheel press, built by the Niles Tool Works. The motor, which is a 10 h.-p. multiple-voltage Crocker-Wheeler motor, is geared direct through a single-reduction to the eccentric shaft from which the pumps are actuated. This is an excellent example of the compactness and simplicity offered by the motor drive.



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DRIVEN BY MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

200-TON NILES WHEEL PRESS.
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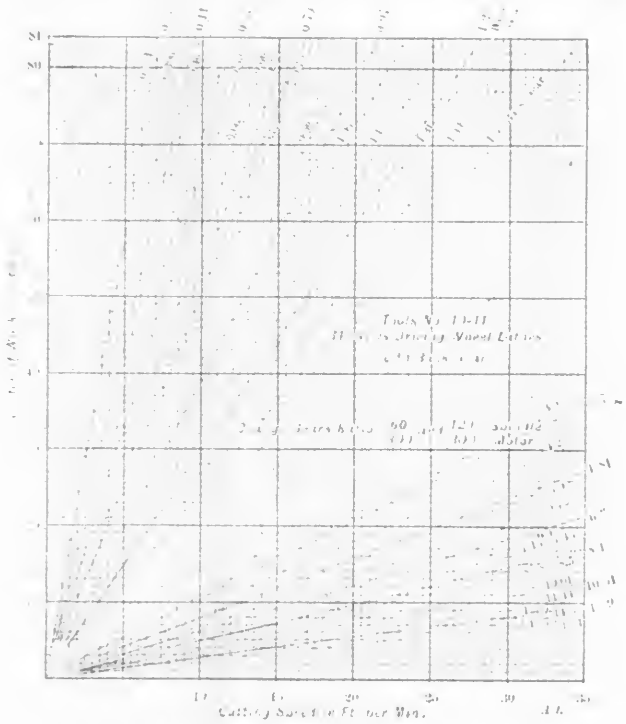

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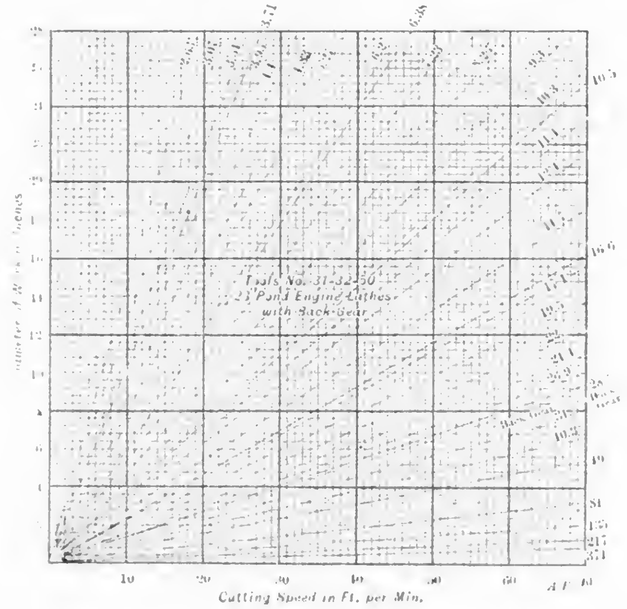

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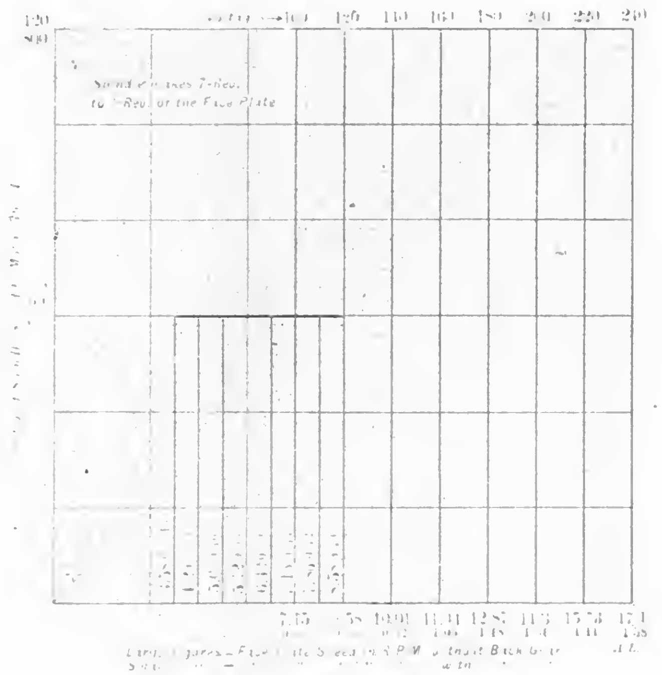

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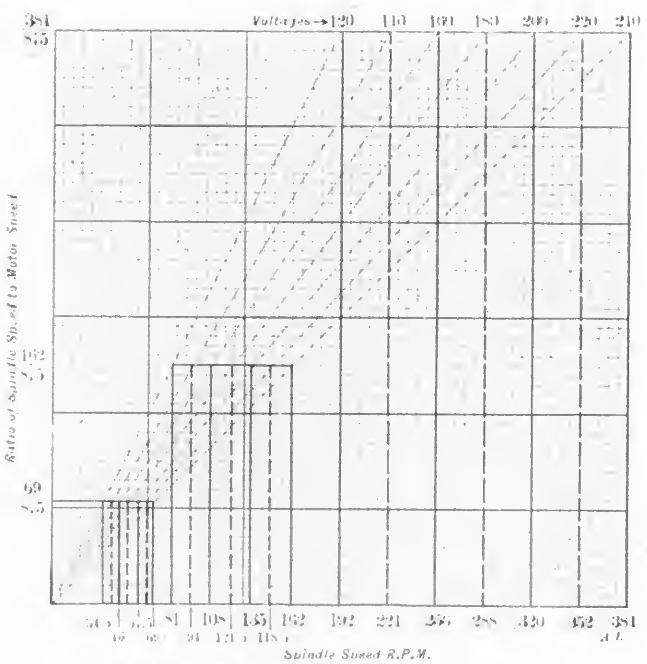

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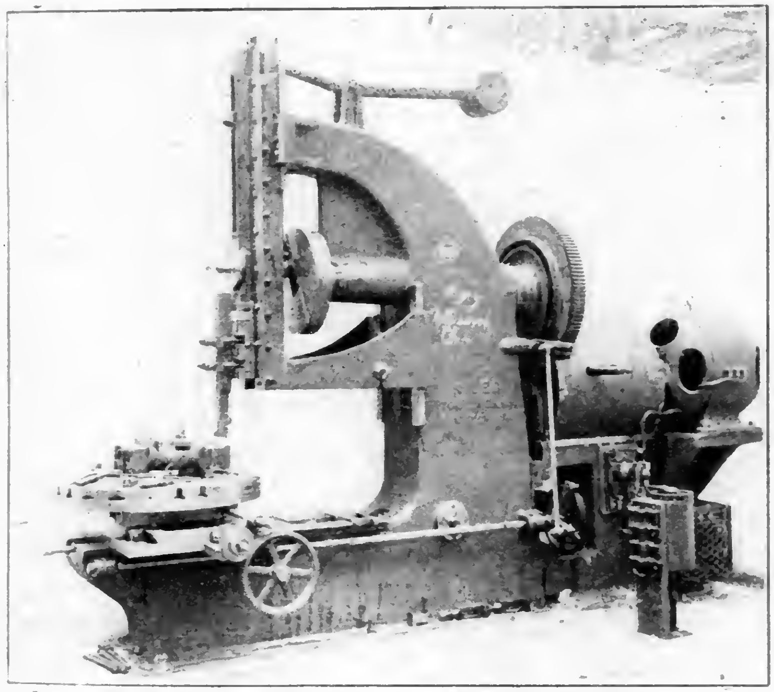

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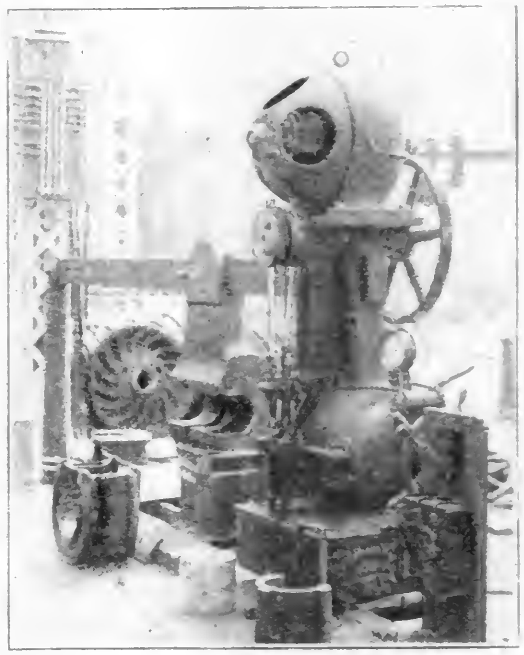

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2—8—0 TYPE.

BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.

SCHENECTADY WORKS.

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Total weight (pounds)	181,200	207,900
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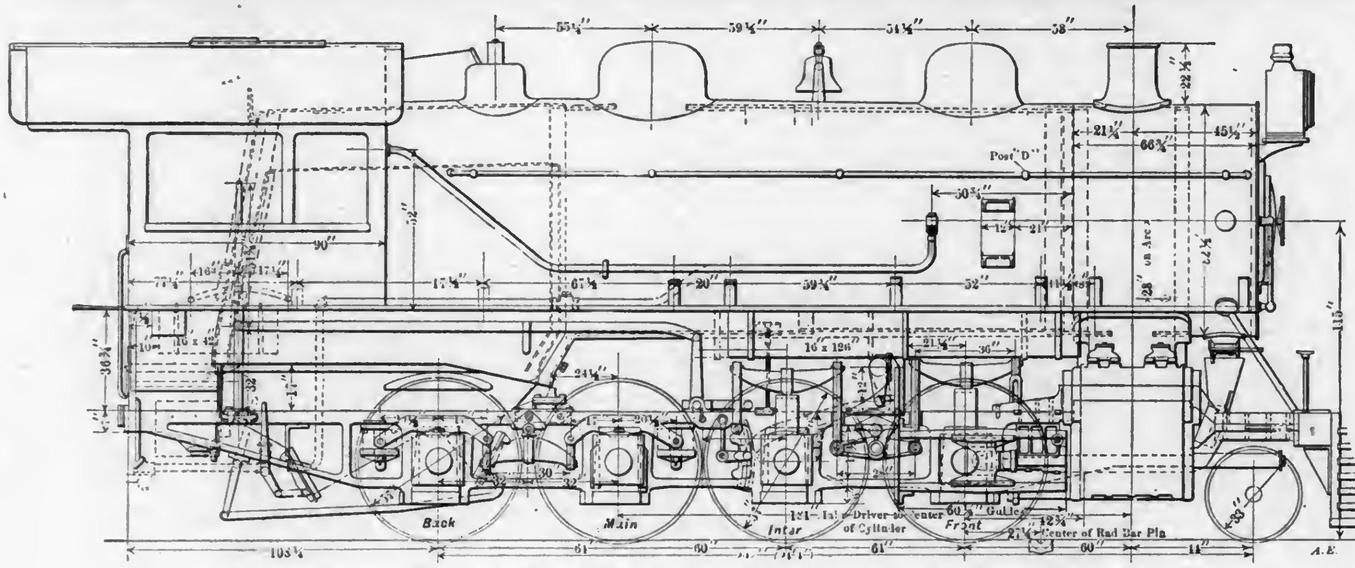

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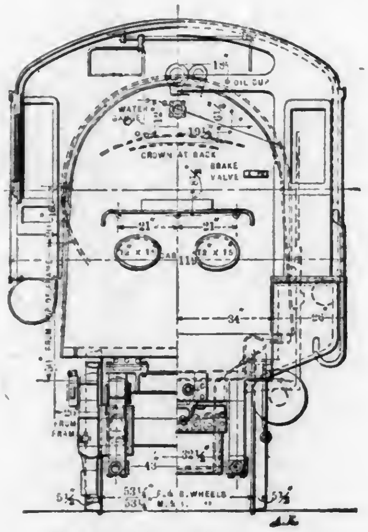

VIEW OF FIREBOX AND CAB.

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FREIGHT LOCOMOTIVE—C., B. & Q. RAILWAY.

2—8—0 TYPE.

General Dimensions.

Fuel	Bituminous coal
Weight in working order	207,900 lbs.
Weight on drivers	181,000 lbs.
Weight engine and tender in working order	320,100 lbs.
Wheel base, driving	15 ft. 8 ins.
Wheel base, rigid	15 ft. 8 ins.
Wheel base, total	24 ft. 4 ins.
Wheel base, total, engine and tender	55 ft. 2¼ ins.

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	28 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	4 ins.

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	⅛ in.
Lead of valves in full gear,	Line and line at front, with ¼-in. lead at one-quarter cut-off
Transmission bar	With

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	57 ins.
Thickness of tire	3½ ins.
Driving box material	Main, cast steel; others, steeled cast iron
Diameter and length of driving journals,	9½ ins. and 9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals,	(Main side, 7¾ ins. x 4¾ ins.) 7 ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals,	(Intermediate, 5¾ ins. x 4½ ins.) 5½ ins. diameter x 3¾ ins.
Engine truck, kind	Two-wheel, swing bolster
Engine truck, journals	6 ins. diameter x 10 ins.
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheels	Cast-iron spoke center, with 2½-in. tire

Boiler.

Style	Straight
Outside diameter of first ring	78 ins.
Working pressure	210 lbs.
Material of barrel and outside of firebox	Steel
Thickness of plates in barrel and outside of firebox,	9-16 in., ⅝ in., ¾ in., 13-16 in., ⅞ in. and 1 in.
Firebox, length	108 ins.
Firebox, width	72¼ ins.
Firebox, depth	Front, 79¼ ins.; back, 68½ ins.
Firebox, material	Steel
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, 9-16 in.
Firebox, water space	Front, 4½ ins.; sides, 4½ ins.; back, 4½ ins.
Firebox, crown staying	Radial
Tubes, number	462
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft.
Firebrick, supported on	Water tubes
Heating surface, tubes	3,605.8 sq. ft.
Heating surface, water tubes	26.71 sq. ft.
Heating surface, firebox	195.06 sq. ft.
Heating surface, total	3,827.57 sq. ft.
Grate surface	54.21 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5½ ins., 5¾ ins. and 6 ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	15 ft.

Tender.

Weight, empty	42,200 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	16 ft. 10 ins.
Tender frame	Wood, with center sills of steel
Water capacity	6,000 U. S. gals.
Coal capacity	12 tons

The United States Geological Survey is at work on a new map of the Grand Canyon of Arizona. Considerable progress has been made. Some of the lines of sight between triangulation stations are 70 miles long, and as observations can only be made to good advantage between sunrise and 9 A. M. or between 4 P. M. and sunset the work is necessarily slow. The signals flash an easily deciphered light only an inch square as far as from Kendrick Peak to Point Sublime, a distance of 68 miles. Accurate elevations have been established on the Bright Angel trail, and it is no longer necessary to guess how high one is above sea level. It is now known that from the rim of the south wall to the river is a drop of 4,430 ft. at Bright Angel and 4,913 ft. at Grand View, while from the north rim the distance is several hundred feet greater, or more than a mile. Twenty buildings like the Masonic Temple, Chicago, could be superimposed in the deepest gorge of the Grand Canyon without reaching the top.

THE NEW ROUNDHOUSE AT RENSSELAER.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

HEATING AND LIGHTING SYSTEMS.

This roundhouse has 30 stalls, and will have 50 when increased facilities are required at this point. The extension is shown in dotted lines in the plan. In selecting the engravings an effort was made to include as much information as possible in the illustrations. The equipment includes shops, storehouse, oilroom, office, rest-room, boiler-room, and facilities for handling coal and ashes. The heating system is especially interesting, this being one of the best equipped roundhouses in this respect ever built. It is also very well lighted.

The fans draw air through heater coils and deliver it into underground ducts at the outer wall of the building. These ducts decrease in cross-sectional area, as indicated in the engravings, in order to secure uniform delivery at the pits which are most remote from the fans. Each pit opening has a thimble and damper, and the locations of the delivery of heated air against the engines and tenders are shown in the plan. Instead of following their usual practice, the contractors, the B. F. Sturtevant Company, provided unusually large heating surfaces and ample fan capacity, with a view to ventilating as well as heating the building.

For convenience, the following information is arranged in a table:

Fans, type	Three-quarters housing
Fans diameter	10 ft.
Fans, width of housing	5 ft.
Engines, cylinders	10 by 12 ins
Engines, nominal horse-power	32
Fan discharge (each fan)—	
At 140 revs. per min.	62,000 cu. ft. per min.
At 160 revs. per min.	70,000 cu. ft. per min.
Cubical contents of 30 stalls	847,600 cu. ft.
Air changed, normally	Eight times per hour
Area inlet, each fan	4,320 sq. in.
Velocity at inlet	2,333 ft. per min.
Combined area of outlets	10 856 sq. in.
Velocity at outlets	933 ft. per min.
Pressure at inlet	¼ oz.
Pressure at outlets	Less than ⅛ oz.
Heater piping, each fan	11,080 ft., 1-in. pipe
Steam pressure for engines	80 lbs.
Steam pressure for heaters—live steam	10 lbs.
Heating surface (exterior) of 22,160 ft. of 1-in. pipe	7,641 sq. ft.
Volume of building per square foot of total pipe heating surface,	111 cu. ft.

Each heater consists of two groups of five sections of four rows each, containing 11,080 linear feet of 1-in. pipe, exclusive of the fittings. Two of these sections are arranged to receive the exhaust of the fan engines and two water-service pumps, also of the receiver pump, which are placed in the fanhouse, and the other sections use live steam piped around the house from the boiler-room. The inlet to the first two and the last three sections of the heater groups are separated by blank flanges, so that either two, three or five sections may be heated independently. The contractors guarantee the heaters to warm all parts of the building to a uniform temperature of 65 degs. when the outside temperature is at zero. Tests have not yet been made, but the guarantee is believed to be fully and amply met. Air from the building or from out of doors may be taken through the heaters, as desired. Roof ventilators and wooden smoke jacks are arranged as indicated in the drawings. This installation sets a high standard in the heating and ventilation of roundhouses.

The shops and offices are heated by live steam from the boilers, the pressure being reduced by a reducing valve at the boiler header. The radiators provide 1 sq. ft. of radiating surface for 80 cu. ft. of space in the various rooms, the pipe coils being of 1½-in. pipe. Steam is supplied by three water-tube boilers of 125 h. p. each, furnished by the Franklin Boiler Works Company, of Troy, N. Y. The stack is of steel plate, 135 ft. high, and of the self-sustained type. This construction and other interesting standards of roundhouse construction on this road will be presented in another article.

The standard method of roundhouse lighting of this road is

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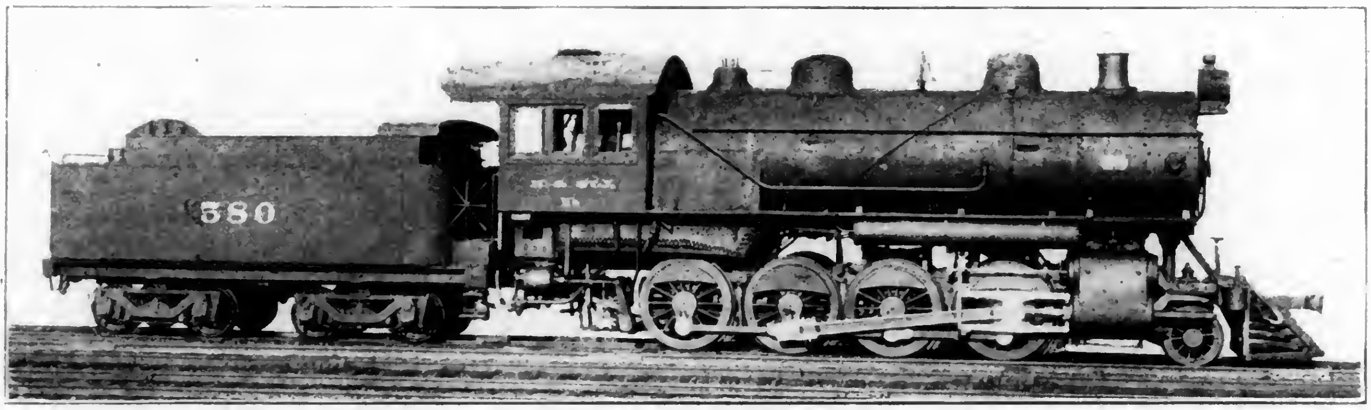

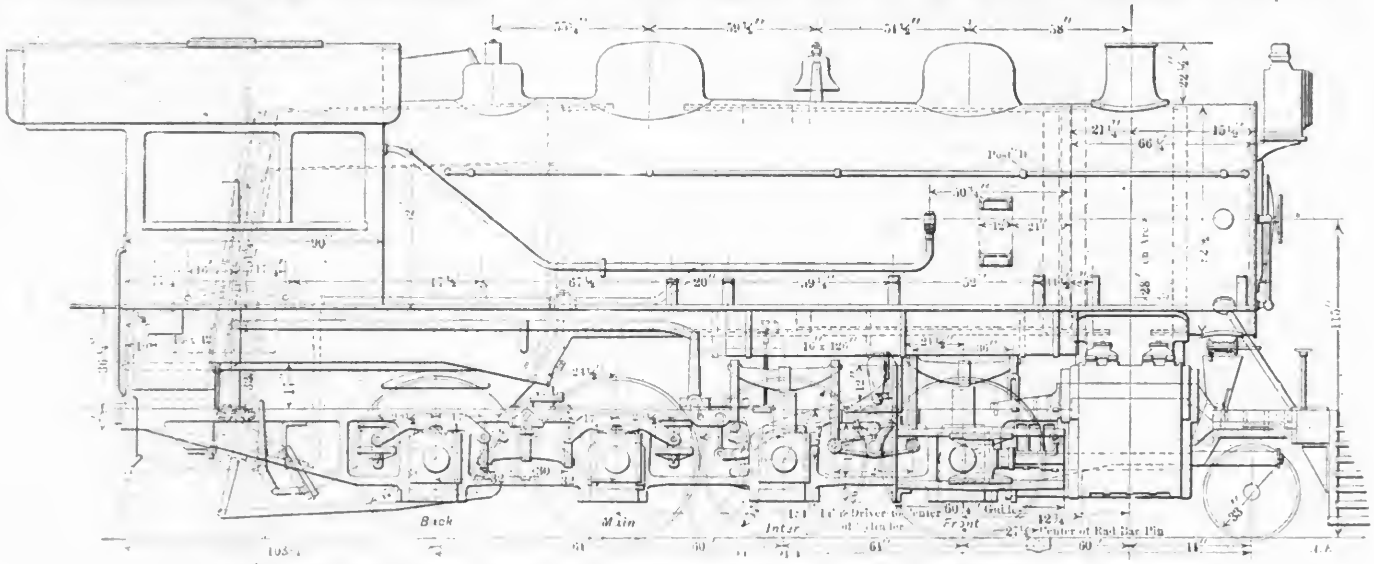

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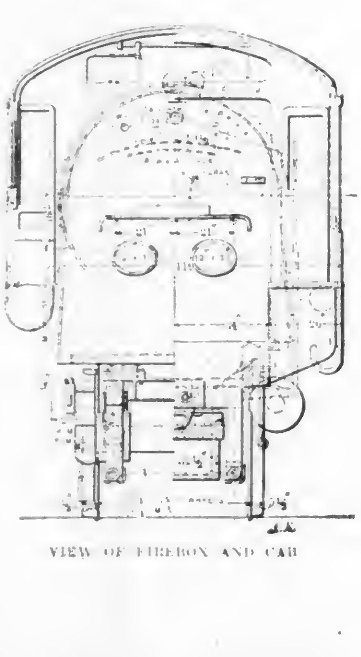

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Wheel base, rigid	15 ft. 8 ins.
Wheel base, total	24 ft. 4 ins.
Wheel base, total, engine and tender	55 ft. $2\frac{1}{4}$ ins.

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	28 ins.
Horizontal thickness of piston	$5\frac{1}{2}$ ins.
Diameter of piston rod	4 ins.

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	$\frac{1}{8}$ in.
Lead of valves in full gear	Line and line at front, with $\frac{1}{4}$-in. lead at one-quarter cut-off
Transmission bar	With

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	57 ins.
Thickness of tire	$3\frac{1}{2}$ ins.
Driving box material	Main, cast steel; others, steeled cast iron
Diameter and length of driving journals	$9\frac{1}{2}$ ins. and 9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals	(Main side, $7\frac{3}{4}$ ins. x $4\frac{3}{4}$ ins.) 7 ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals	(Intermediate, $5\frac{3}{4}$ ins. x $4\frac{1}{2}$ ins.) $5\frac{1}{2}$ ins. diameter x $3\frac{3}{4}$ ins.
Engine truck, kind	Two-wheel, swing bolster
Engine truck, journals	6 ins. diameter x 10 ins.
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheels	Cast-iron spoke center, with $2\frac{1}{2}$-in. tire

Boiler.

Style	Straight
Outside diameter of first ring	78 ins.
Working pressure	210 lbs.
Material of barrel and outside of firebox	Steel
Thickness of plates in barrel and outside of firebox	9-16 in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., 13-16 in., $\frac{7}{8}$ in. and 1 in.
Firebox, length	108 ins.
Firebox, width	$72\frac{1}{4}$ ins.
Firebox, depth	Front, $79\frac{1}{4}$ ins.; back, $68\frac{1}{2}$ ins.
Firebox, material	Steel
Firebox plates, thickness	Sides, $\frac{3}{8}$ in.; back, $\frac{3}{8}$ in., crown, $\frac{3}{8}$ in.; tube sheet, 9-16 in.
Firebox, water space	Front, $4\frac{1}{2}$ ins.; sides, $4\frac{1}{2}$ ins.; back, $4\frac{1}{2}$ ins.
Firebox, crown staying	Radial
Tubes, number	462
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft.
Firebrick, supported on	Water tubes
Heating surface, tubes	3,605.8 sq. ft.
Heating surface, water tubes	26.71 sq. ft.
Heating surface, firebox	195.06 sq. ft.
Heating surface, total	3,827.57 sq. ft.
Grate surface	54.21 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	$5\frac{1}{2}$ ins., $5\frac{3}{4}$ ins. and 6 ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	15 ft.

Tender.

Weight, empty	42,200 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	16 ft. 10 ins.
Tender frame	Wood, with center sills of steel
Water capacity	6,000 U. S. gals.
Coal capacity	12 tons

The United States Geological Survey is at work on a new map of the Grand Canyon of Arizona. Considerable progress has been made. Some of the lines of sight between triangulation stations are 70 miles long, and as observations can only be made to good advantage between sunrise and 9 A. M. or between 4 P. M. and sunset the work is necessarily slow. The signals flash an easily deciphered light only an inch square as far as from Kendrick Peak to Point Sublime, a distance of 68 miles. Accurate elevations have been established on the Bright Angel trail, and it is no longer necessary to guess how high one is above sea level. It is now known that from the rim of the south wall to the river is a drop of 4,430 ft. at Bright Angel and 4,913 ft. at Grand View, while from the north rim the distance is several hundred feet greater, or more than a mile. Twenty buildings like the Masonic Temple, Chicago, could be superimposed in the deepest gorge of the Grand Canyon without reaching the top.

THE NEW ROUNDHOUSE AT RENSSELAER.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

HEATING AND LIGHTING SYSTEMS.

This roundhouse has 30 stalls, and will have 50 when increased facilities are required at this point. The extension is shown in dotted lines in the plan. In selecting the engravings an effort was made to include as much information as possible in the illustrations. The equipment includes shops, storehouse, oilroom, office, rest-room, boiler-room, and facilities for handling coal and ashes. The heating system is especially interesting, this being one of the best equipped roundhouses in this respect ever built. It is also very well lighted.

The fans draw air through heater coils and deliver it into underground ducts at the outer wall of the building. These ducts decrease in cross-sectional area, as indicated in the engravings, in order to secure uniform delivery at the pits which are most remote from the fans. Each pit opening has a thimble and damper, and the locations of the delivery of heated air against the engines and tenders are shown in the plan. Instead of following their usual practice, the contractors, the B. F. Sturtevant Company, provided unusually large heating surfaces and ample fan capacity, with a view to ventilating as well as heating the building.

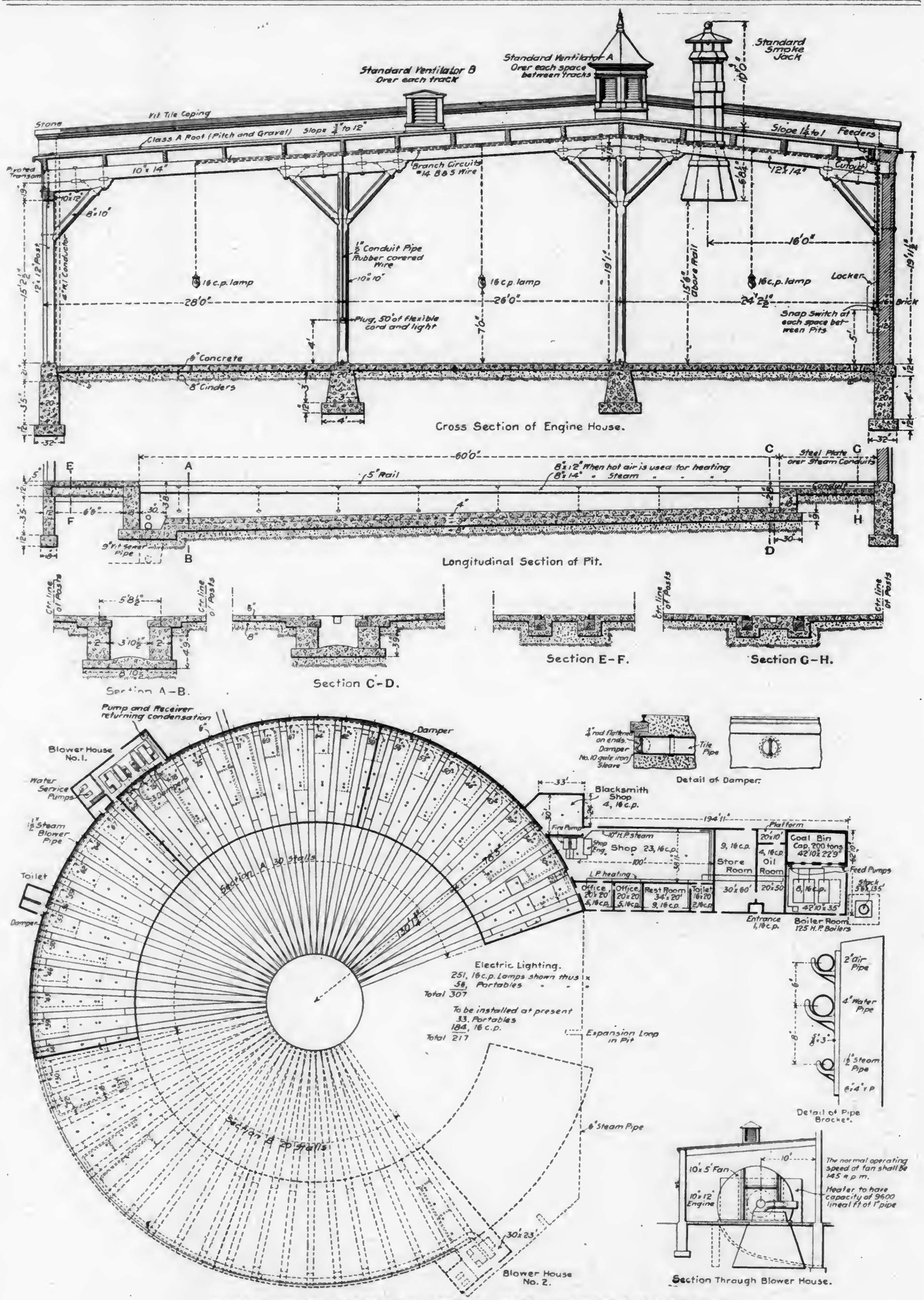
For convenience, the following information is arranged in a table:

Fans, type	Three-quarters housing
Fans diameter	10 ft
Fans, width of housing	5 ft
Engines, cylinders	10 by 12 ins
Engines, nominal horse-power	32
Fan discharge (each fan)	
At 140 revs. per min.	62,000 cu. ft. per min
At 160 revs. per min.	70,000 cu. ft. per min
Cubical contents of 30 stalls	847,600 cu. ft.
Air changed, normally	Eight times per hour
Area inlet, each fan	4,320 sq. in
Velocity at inlet	2,333 ft. per min
Combined area of outlets	10,856 sq. in
Velocity at outlets	933 ft. per min.
Pressure at inlet	$\frac{1}{4}$ oz
Pressure at outlets	Less than $\frac{1}{4}$ oz.
Heater piping, each fan	11,080 ft., 1-in. pipe
Steam pressure for engines	80 lbs.
Steam pressure for heaters—live steam	10 lbs
Heating surface (exterior) of 22,160 ft. of 1-in. pipe	7,641 sq. ft
Volume of building per square foot of total pipe heating surface	111 cu. ft

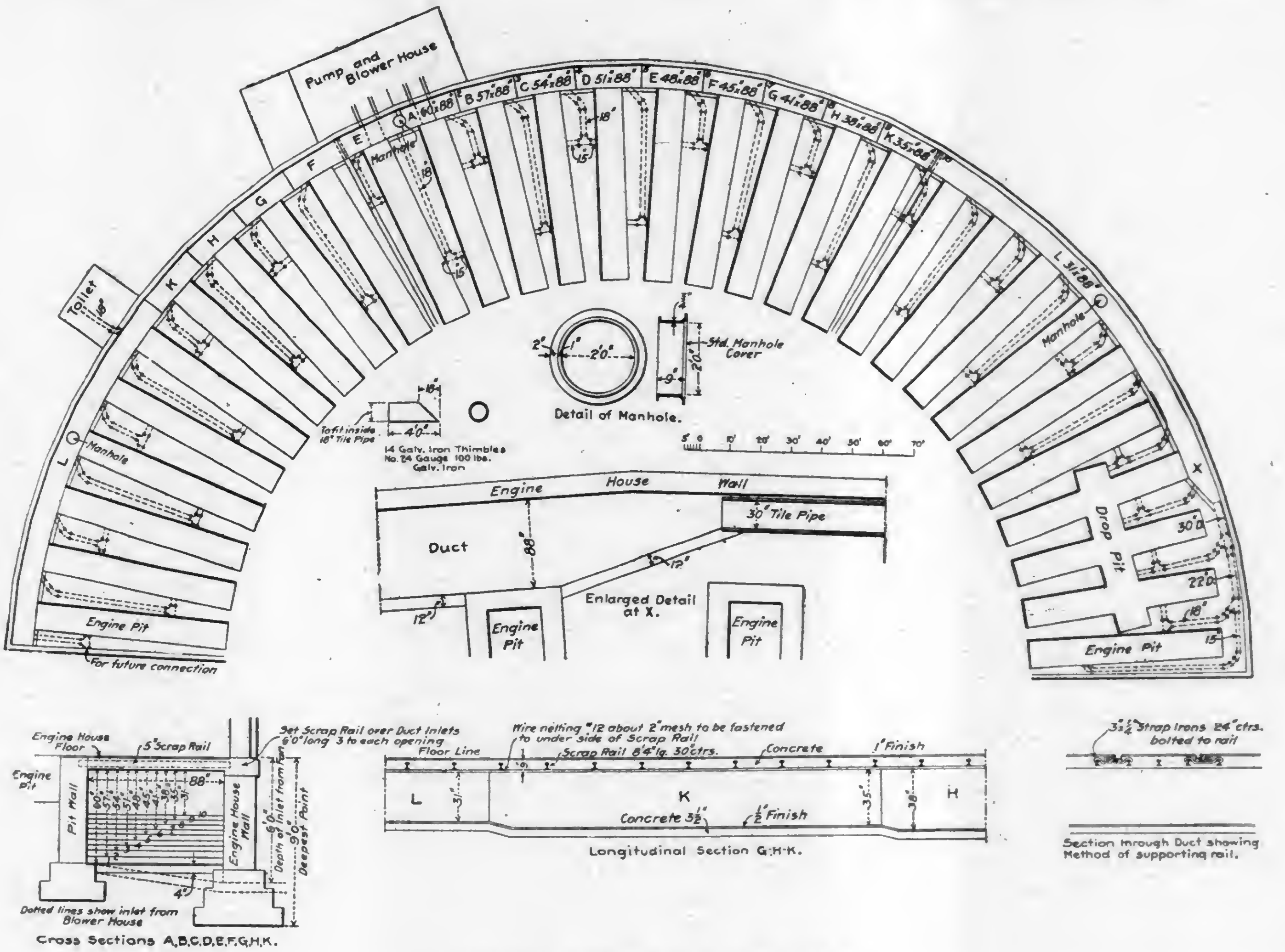
Each heater consists of two groups of five sections of four rows each, containing 11,080 linear feet of 1-in. pipe, exclusive of the fittings. Two of these sections are arranged to receive the exhaust of the fan engines and two water-service pumps, also of the receiver pump, which are placed in the fanhouse, and the other sections use live steam piped around the house from the boiler-room. The inlet to the first two and the last three sections of the heater groups are separated by blank flanges, so that either two, three or five sections may be heated independently. The contractors guarantee the heaters to warm all parts of the building to a uniform temperature of 65 degs. when the outside temperature is at zero. Tests have not yet been made, but the guarantee is believed to be fully and amply met. Air from the building or from out of doors may be taken through the heaters, as desired. Roof ventilators and wooden smoke jacks are arranged as indicated in the drawings. This installation sets a high standard in the heating and ventilation of roundhouses.

The shops and offices are heated by live steam from the boilers, the pressure being reduced by a reducing valve at the boiler header. The radiators provide 1 sq. ft. of radiating surface for 80 cu. ft. of space in the various rooms, the pipe coils being of $1\frac{1}{2}$-in. pipe. Steam is supplied by three water-tube boilers of 125 h. p. each, furnished by the Franklin Boiler Works Company, of Troy, N. Y. The stack is of steel plate, 135 ft. high, and of the self-sustained type. This construction and other interesting standards of roundhouse construction on this road will be presented in another article.

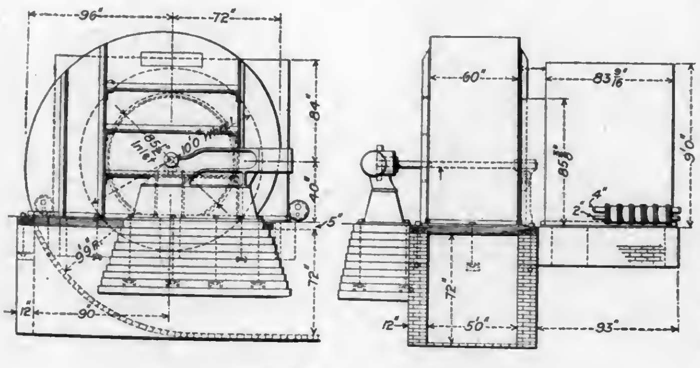
The standard method of roundhouse lighting of this road is



NEW ROUNDHOUSE AT RENSSELAER, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.



ARRANGEMENT OF HEATING DUCTS AND DELIVERIES.



ONE OF THE FAN HEATER UNITS.

used in this installation. In the spaces between pits are three 16 candle-power pendant lamps, and at each pit is a plug on one of the posts, to which a portable lamp may be connected for use under engines. On the outer wall at each space is a four-point snap switch. The first point controls the lamp at the pilot ends of the engines; the second point controls the other two pendant lamps, and the plug is in circuit at all times. This plan lights the passage around the house without requiring all the lamps to be lighted. The lamps are in two-wire circuits from three-wire alternating-current feeders, the voltage of the lamps being 110. Special care was taken in the construction of the flexible cords, and the lamps are protected by aluminum cages. Current for lighting is taken from the feeders of the Albany and Hudson Railway and Power Company.

The design and construction of the heating and lighting were carried out by Mr. Edwin B. Katte, mechanical engineer, under the direction of Mr. W. J. Wilgus, chief engineer of the road.

Agitation of the passenger-transportation problem in New York City has led to several sensible suggestions for relief from crowding, but the root of the matter has not yet been reached. It is wise to extend third tracks and separate long and short distance travel. It is necessary to have a sufficient number of cars, and obviously, enough trains must be run. All of these things are perfectly clear even to the office boy of a railroad officer, and such conclusions should not require several lengthy sessions of a body of the dignity of the railroad commission of a great State. When these improvements have been made, there yet remains the most serious difficulty—that of getting passengers into and out of the cars quickly. It appears that the primitive construction of cars with end doors, swinging gates, and narrow passages for entering and leaving, has not been brought to the attention of the investigators. To the suggested improvements should be added a lesson from the method of the Illinois Central in handling the crowds at the Chicago World's Fair, which stands to this time as the most successful transportation of large crowds of passengers. The New York situation requires the application of the principles of that method. We shall have more to say upon this subject.

CORRESPONDENCE.

THIRTY-TON BOX CAR WITH STEEL UNDERFRAME.

To the Editor:

In your January issue there appears among the many good things a description of a box car of composite type of construction, differing from the old practice in the substituting of steel sills of channel section for those of wood. Since an invitation is extended to criticise this car, the conclusion is a reasonable one that somebody will ask the why and wherefore of certain features of design.

There is considerable original thought in this design, but the question presents itself as to why the channel sills in connection with intermediate sills and truss-rods should be used, if reduction of dead weight was a desideratum, as calculation seems to show that there is a difference of over 700 lbs. in favor of six wooden sills and four 1⅜-in. truss-rods. The four truss-rods would be subjected to a unit stress of about 9,000 lbs., with no aid whatever from the sills, while the two 1⅝-in. rods would have less work to do, since the channel sills would carry a certain percentage of the load and thus relieve the rods to that extent. Under these conditions, would it not have been a better construction to use pressed steel sills of a fish-belly section without rods, and of such a depth as to give a correct resisting moment for the load? If weight restrictions stand in the way, this construction, as well as the wooden sills, point the way to a solution of the problem, and allows some metal to be put in the bolsters, where it is too often needed. The arrangement of the truss-rods in this car could not be improved on greatly, as they are disposed so as to deposit their loads on the bolsters near the center sills and thus give a minimum bending moment on the bolsters; and a further evidence that the designer knew the triangle of forces is shown in the location of the crossties so as to have a short diagonal length in the truss-rods—an arrangement which will produce the lowest tensile stress in the rods. The center sills are latticed on the top, so says the description; at this I marvel, for the center sills cannot be in the best condition to resist the compression stresses due to the horizontal component of the truss-rod load, without being latticed on both top and bottom sides. If this proposition holds for static loads, what about buffing strains, which are believed to range from 100,000 to 300,000 lbs., if a report to the Western Railway Club on tests made with the Westinghouse Dynamometer car by the Lake Shore Railway is entitled to credence.

A further examination of the details of this car would seem to show a weak body bolster, which is of the double plate type, consisting of a top and bottom member, both of which are ½ in. thick by 12 ins. wide, between which is a ½ x 5-in. plate extending from the top of the center sills to the lower plate of the bolster at a point just above the side bearings. The function of this narrow plate being apparently that of a strut to receive the thrust of the side bearings, although it does afford a certain relief to the tension in the upper plate of the bolster. To say or think a thing is weak carries no weight if proof is not added to substantiate the position.

The test of the pencil, based on an assumed light weight of car at 32,000 lbs., minus trucks at 6,000 lbs. each, gives, with the 60,000 lbs. rated capacity of the car, a load of 80,000 lbs. to be sustained by the bolsters.

Assuming again—and these figures are necessarily assumptions, since no weight is given—that the light weight is correct and that the load is uniformly distributed on one half the bolster, we have 8,521 lbs. uniformly distributed load, in addition to which there is a concentrated load of 9,040 lbs. deposited on the bolster by one truss-rod. These loads produce a combined bending moment of 237,735 in.-lbs. with a resulting tensile unit stress of about 8,000 lbs. in the upper plate of the bolster, which would be safe if backed by a lower plate of proper rigidity, but the lower plate has a danger zone between the side bearing and lower flange of the center sills, for a distance of practically 18 ins., and this ½-in. lower member is therefore subjected to a compression unit stress of 8,780 lbs. Authorities on strength of materials tell us that the greatest safe load in compression for a column of steel of about 70,000 tensile strength should not exceed 7,000 lbs. for a ratio of $l \div r$, in which $l =$ length of column and $r =$ least radius of gyration—the column supposed to have fixed ends. Calculated on this basis, the bolsters would scarcely carry their static load free from the side bearings. Perhaps that was the intent of the designer; if so, investigation of the problem would be "love's labor lost"; but it will not be out of place to say that many good designers have aimed to produce a bolster that would stand alone and thus decrease curve resistance, always seeking to reduce dead weight in any other detail of a car rather than have a weak bolster.

There are some novel things about this car, but the thought presents itself that if steel is a good thing—and no one will say that it is not—in the under-framing, why not follow out the metal idea to its logical conclusion and build a standard steel box car, as is now looked upon favorably by many progressive car designers. It is to be hoped that sufficient force of opinion will be brought to bear in this question to soon break through the hard shell of conservatism in which it has been too long enveloped.

O. H. REYNOLDS.

To the Editor:

With regard to the 30-ton box car designed by Mr. George I. King and illustrated in the January number of the American Engineer and Railroad Journal, I wish to submit the following:

Structural steel underframing has been considered many times with a view of having one design answer for the various types of freight cars. This is a very good scheme, and would probably serve some roads very well, where they wished to have the fewest possible number of different designs and, consequently, have to carry the least number of different parts in stock, being at the same time those of a standard section which can easily be secured on the market. One other good feature of standard sections is that there need be no unnecessary delay in getting material for the construction of these cars, as no special machines are required in preparing material or constructing them in any car works. They can very easily be constructed in the car shops of any railroad; hence the ease with which the car may not only be constructed but repaired. The best feature in the construction where truss-rods are used is a minimum weight of car for the load carried. If all of these goods points are to be maintained without serious weakness entering into the construction, we will have attained a good purpose.

Considering the steel underframe shown in the January issue of your journal, the weakest point of this design is the body bolster. It is not rigid enough to transfer the load of the side sills to the center plate. The lower member of the bolster is brought up to the upper member as it leaves the center sill. While it may be necessary to do this to provide clearance below the bolster, and is allowable to some extent, and yet maintain sufficient strength, in this construction we have only the resistance of two ½-in. x 12-in. plates to sustain the load on the side sills. Probably a better construction would be to carry the lower member horizontally from the center sill to the side sill, or as nearly horizontal as allowable for clearance. It would then be necessary to stiffen the lower member to prevent buckling; this could be done by bolting the two plates together above the side bearing, using a distance piece or ferrule between the upper and lower members.

The manner of securing the ends of the truss-rods to the bolster is a little weak. While the size of the rivets is not given, it would be necessary to use two ⅞-in. rivets; even then this would not be a secure fastening, as the rivets might tear through either the plate or strap, or the heads might snap off. A better way to secure these straps would be to rivet them on the top of the bolster instead of on the bottom.

The gusset plates at the end of the frame, which are turned up to act as stops for the end of the car body, would constitute a good arrangement, provided it were possible to hold the body down tight against the gusset plates. As this is impossible, it would be only a short time before these plates would be battered out, allowing the end of the car to follow. A shifting load would bring this about very rapidly. It would be best to have cast pockets for the bases of the end posts and braces. The pockets could be well fastened to the sills, thus preventing the ends from bulging out, and they would also strengthen the end of the car body laterally.

If we consider the corner of the frame, as regards strength for poling, we find that we can depend only on the side sill and diagonal angle. The light end sill, which is a ¼-in. pressed "Z" bar, will not be in service long before its properties as a compression member will have been destroyed. If the angle brace becomes the least amount bent, it cannot be depended on, so we have only the side sill left. When poling with a heavy engine, and the pole is at an angle greater than 45 degs. with the center line of the car, and any of the members are distorted, we probably would find that

the safe stress limit would be exceeded in the members. A better construction for the corner would be to replace the present end sill with one much heavier, and run the diagonal brace from the gusset plate at the end of the center sills to the end of the bolster. This would change the brace from compression to tension, and could be counted on, even though badly distorted. It would also assist in taking the lateral drawbar pressure in curving. The heavy end sill will, in addition, strengthen the frame, and the angle will assist the gusset plate over the body bolster.

When the load of the car is of such a nature as to throw more weight on the side than on the center sills we get a partial equalization through the crossbearer to the truss-rods. But when the excess of the load is on the center sills we cannot count on much assistance from the side sills, for the crossbearer is hung to each of the side sills by two rivets. While the rivets are in good condition they may assist some, but their strength cannot be depended on, as the framing is so flexible that when it is laterally distorted there is imposed upon these rivets severe alternating strains, which will readily impair their strength and likely rupture them in time.

When we consider the steel underframe for a flat or gondola car, we have at times very different conditions to deal with from those of a box or stock car, one of which is a concentrated load. If we consider a concentrated load applied across the sills, the maximum allowable load, within safe limits would be 32,000 lbs., which is not up to the rated capacity of the car. If the load exceeds this limit, we will have a very large deflection and likely a permanent set in the sills, causing an injury to the framing. Again, when the load is of the above nature and immediately over the center sills, the only assistance obtained from the side sills is through the rivets fastening them to the crossbearer. Since these rivets cannot be relied on, we receive no assistance from the side sills, allowing the center sills to take the whole load. Even when the load is entirely distributed the side sills will deflect more than the center sills, as they receive the least support from the truss-rods.

In trying to maintain one design of underframing for the various types of cars there are two things we lose: first, the underframe for a box or stock car need not be as heavy as that of a flat or gondola car of the same rated capacity; second, we have the chance of lightening the weight of the gondola by making the sides assist the side sills in carrying their portion of the load. If we wish the last advantage referred to, it is necessary that the side sill should be immediately under the sides. While we might be able to use the same sills as in the framing for the box and stock cars, yet the spacing of the sills would be changed, thus changing the bolster and crossbearers. There is another feature which could be varied to advantage, by having individual framing for the various classes of cars. In the box and stock car construction the end sills are usually very close to or immediately under the end of the car body, while in the framing for gondola cars it is necessary to have the end sill outside of the end of the car body. This will increase the length of the sills, or else we lose in the volume of the car, which can hardly be afforded, as it impairs its carrying capacity. Thus we see the impracticability of endeavoring to use one underframe for all kinds of freight cars, but we may nevertheless use standard rolled sections for each design of underframing. In the particular design referred to there has been too much sacrifice of strength and rigidity throughout to gain lightness of weight in the car. While this underframing might do for a box or stock car with a few alterations, it is entirely too weak to stand the severe strains which would be imposed upon it if used for a gondola or flat car. R. N. KENNINGTON.

Mr. George F. Wilson, who for twelve years has been superintendent of motive power of the Chicago, Rock Island & Pacific, has resigned and is succeeded by Mr. M. K. Barnum. Mr. Wilson begun service with this road as assistant general master mechanic in 1889. He was made general master mechanic in the same year and superintendent of motive power in 1891, and has a reputation second to none among motive power officials. Mr. Barnum entered the service of the Union Pacific as master mechanic in 1890, after having been connected with the Santa Fé and the Louisville & Nashville. He recently resigned to accept the position of assistant mechanical superintendent of the Southern Railway, which he now leaves to take up his new duties in Chicago.

NEW LOCOMOTIVE SHOPS.

READING, PA.

PHILADELPHIA & READING RAILWAY.

II.

LOCOMOTIVE SHOP.

The skill of the architects has relieved these large buildings of the flat and unattractive appearance of the ordinary construction of railroad shops. This is seen in the present engravings and in the photographs presented in the January number. This description concerns the main or locomotive-shop building. It is of modern steel-skeleton construction, with 17-in. brick walls and 8½ x 38-in. pilasters between the windows. The walls are on concrete footings and are tied to the steel columns, which are otherwise entirely independent of the walls. This building has three bays, with two rows of intermediate columns at 20-ft. centers, this being the distance between the centers of the shop pits.

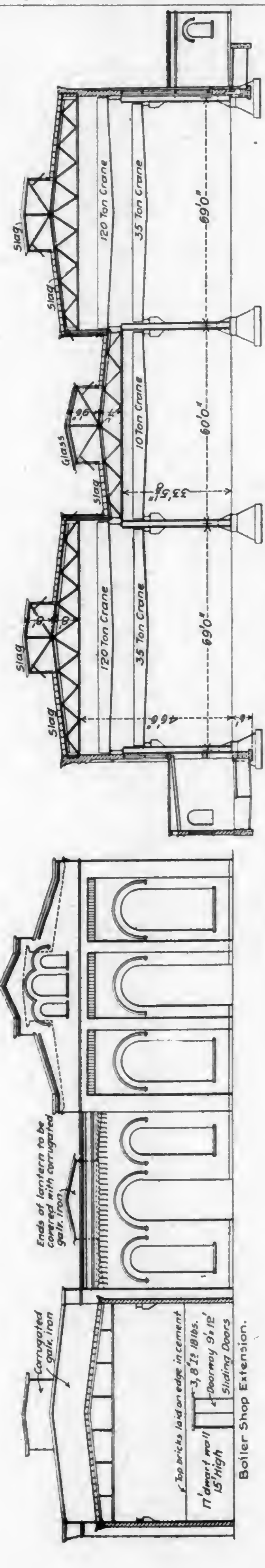
Steelwork.—The steelwork is substantial, and unusual accuracy was required in its construction and fitting. The wall and intermediate columns are very nearly alike up to the crane girders. They are built up of two plate and angle channels, with a double lacing of 2½ x ½-in. bars. Each column is anchored to a concrete granite capped pier, the concrete being of 1 part Portland cement, 2 parts of sand and 5 of broken stone (to pass a 2-in. ring). The column footings and caps are milled to secure a good surface. Upon the tops of these columns rest 4-ft. plate girders for the heavy cranes. The crane rails rest on top of the girders, which are in 20-ft. spans, with ¼-in. expansion spaces, one end of each span being fixed and the other provided with a specially designed expansion connection, which insures the stiffness required for so heavy a runway. The rails for the 120-ton cranes weigh 150 lbs. per yard. Those of the 35 and 10-ton cranes weigh 85 and 70 lbs. respectively, and these are supported on brackets from the intermediate and wall columns. Specially strong construction was required for the heavy rolling loads.

Roofs.—This building has three separate roofs. The intermediate columns carry the ends of the machine-shop roof trusses, and extensions from the ends of these trusses carry the inner ends of the trusses over the erecting bays. The wall columns have extensions in the brick walls to carry the outer ends of these trusses. Purlins and bracing connect the trusses and carry the ventilating monitors.

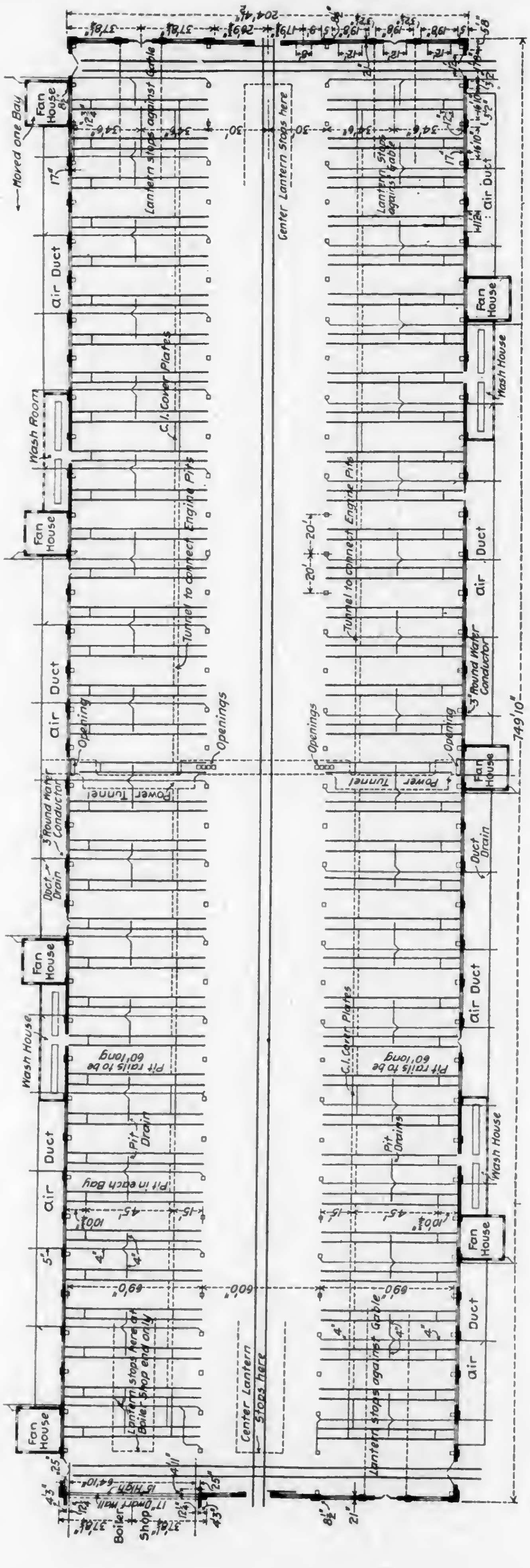
Roofing.—Hemlock boards, 1 by 8 ins., form the basis for the roofing. These are covered by 4-ply overlapping roofing felt laid in cement. As a minimum, 70 lbs. of felt were required per 100 sq. ft. of roof. Cement was spread over this, with a minimum of 10 gals. (including that between the layers of felt) per 100 sq. ft. of roof. Over this is an outer covering of crushed roofing slag.

Glazing.—The side windows are in three parts. At the top is a stationary semi-circular sash with a radius of 57 ins. Below that is a three-section window with rectangular sash, double-hung. The third, or lowest section, is stationary. At the end of the building is a similar window arrangement. In the sides of the roof monitors the sash are pivoted in the center, and so also are those in the walls over the intermediate crane girders, but here only alternate sash are pivoted.

Floor.—Except at the pits which are of concrete the entire floor of this building has a base of bituminous concrete composed of cinders and No. 4 coke-oven composition, in the proportion of 1 gal. to 1 cu. ft. of cinders. This was laid hot and well rammed. In this 6 by 6-in. yellow pine floor stringers are embedded at 4 and 5-ft. centers. These are covered with an under-floor of hemlock plank, surmounted by 1⅛ by 4-in.



PARTIAL, END VIEW AND SECTIONS OF ERECTING AND MACHINE SHOPS.

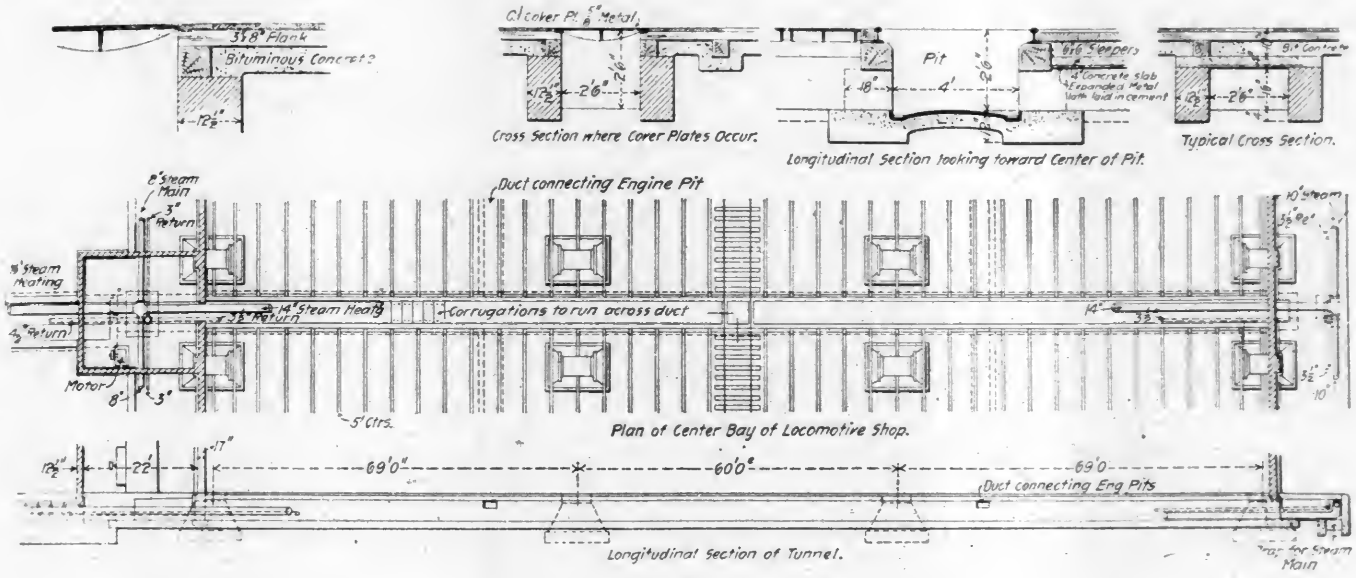


PLAN OF ERECTING AND MACHINE SHOPS.

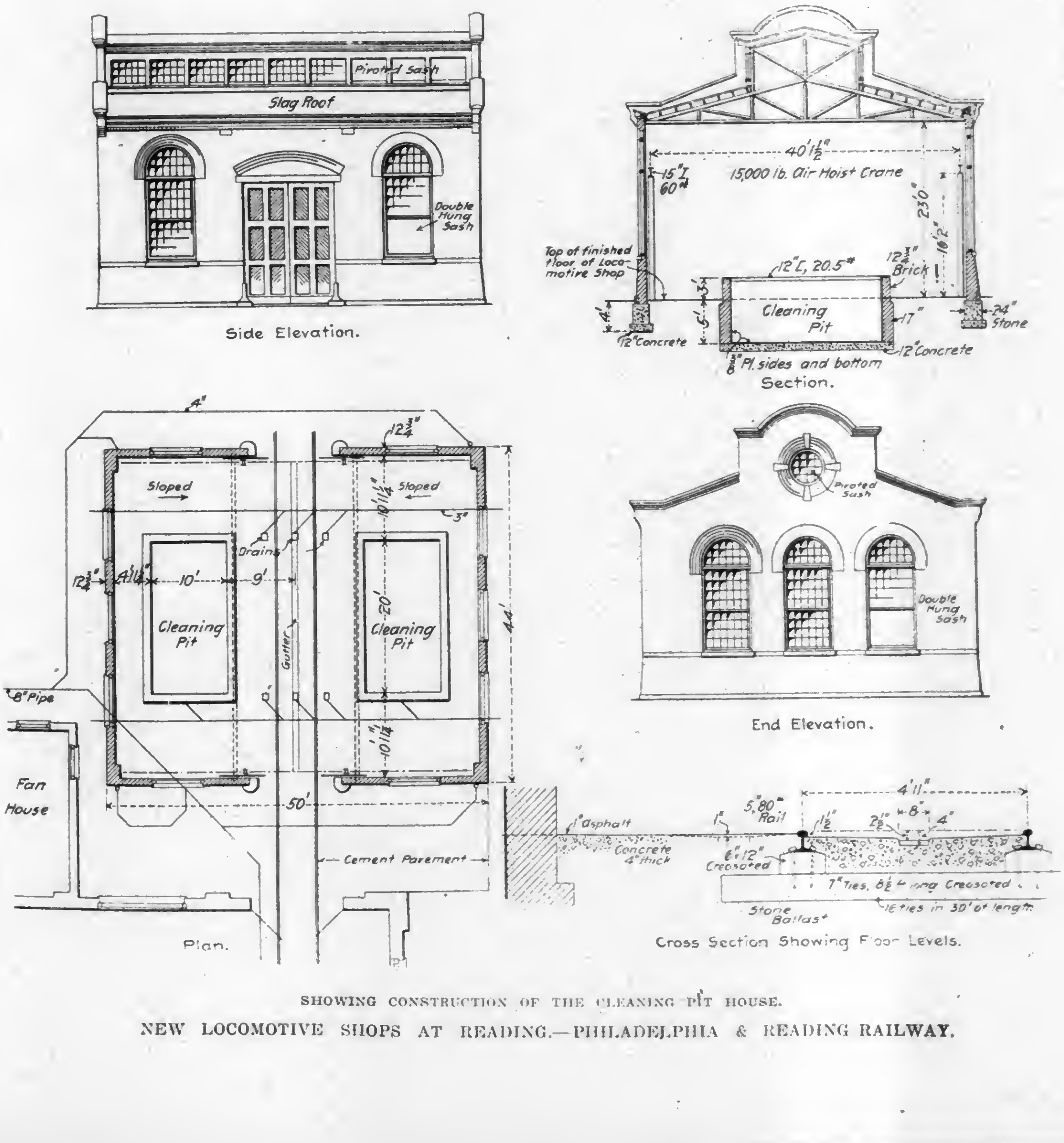
WILSON, HARRIS & RICHARDS, *Architects.*

NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.

S. F. PRINCE, JR., *Superintendent Motive Power.*

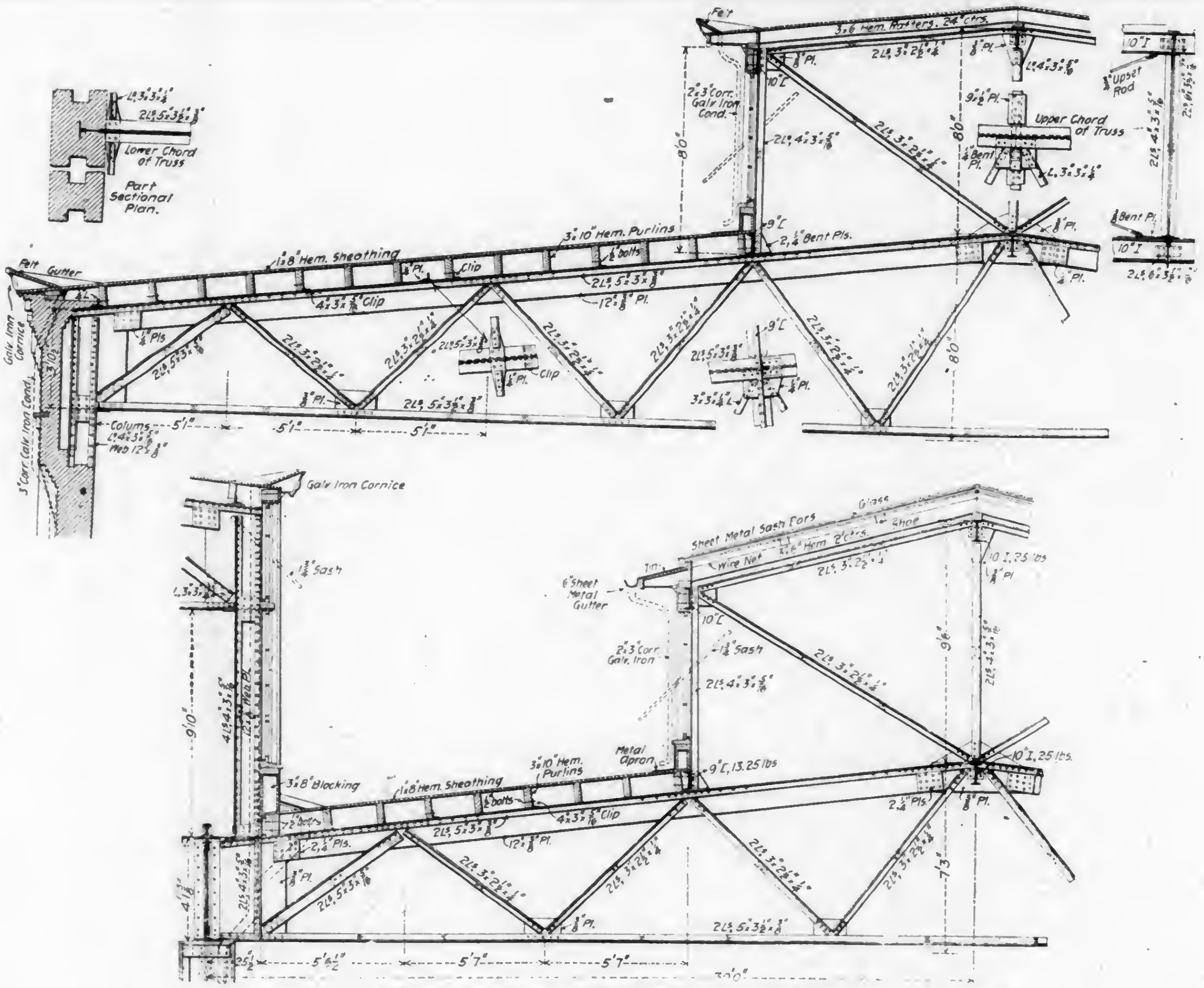


PLAN AND SECTIONS OF PIPE AND CABLE TUNNELS.

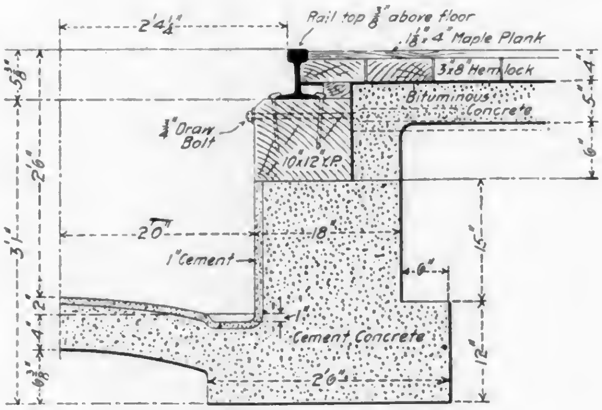


SHOWING CONSTRUCTION OF THE CLEANING PIT HOUSE.

NEW LOCOMOTIVE SHOPS AT READING.—PHILADELPHIA & READING RAILWAY.



ERECTING SHOP AND MACHINE SHOP ROOF TRUSSES.



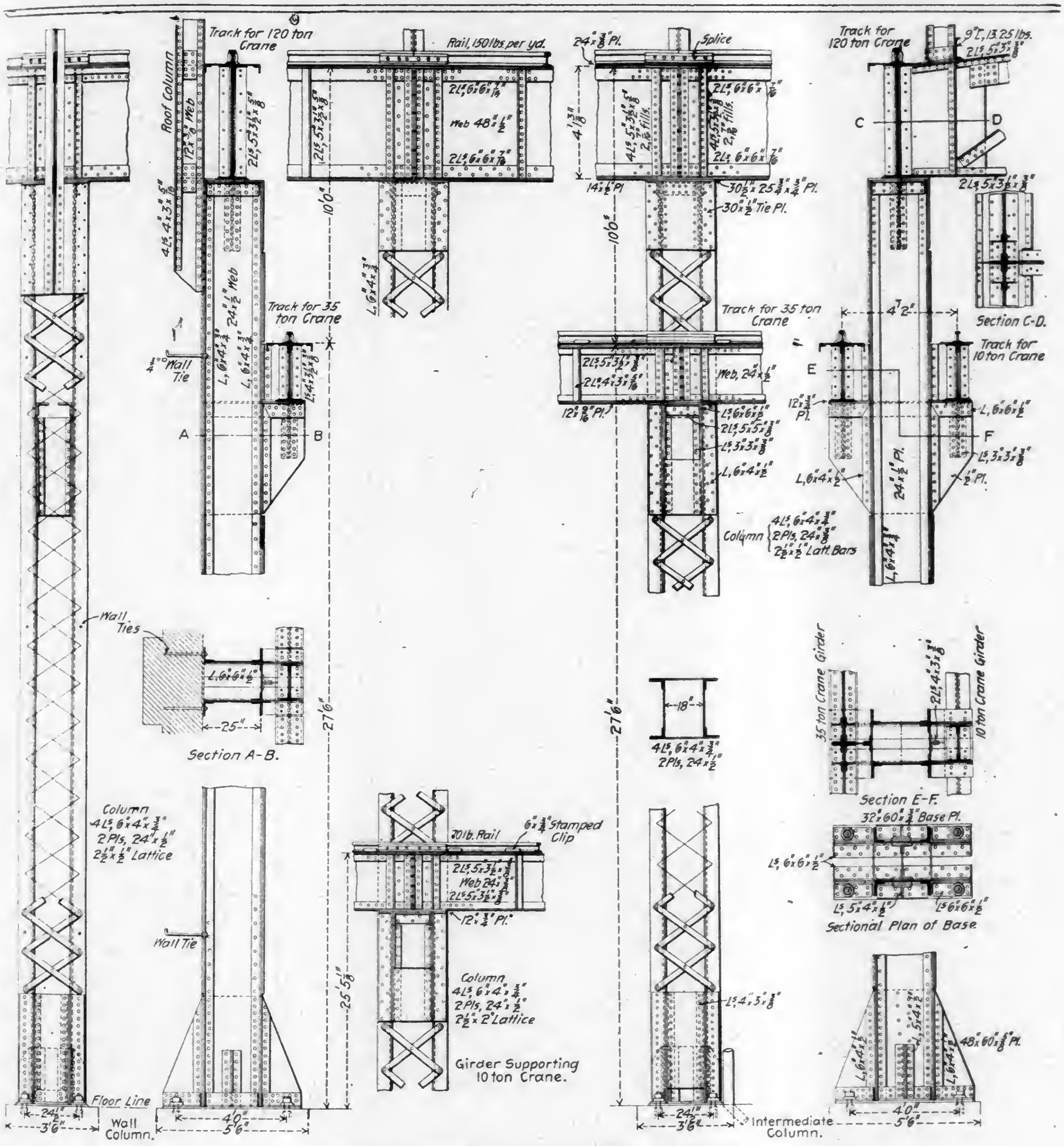
ENLARGED SECTION THROUGH PIT WALLS.

square edge maple flooring. The floor boards are not tongued on the edges, which renders it easy to make repairs.

The locomotive shop combines under one roof two 69-ft. erecting bays, with 35 pits each, and a central 60-ft. machine-shop bay, the building being 740 by 204 ft. The pits are 45 ft. long, with a space of 10 ft. to the outer wall and 15 ft. to the intermediate crane columns. The pits are 2 ft. 6 ins. deep and 4 ft. wide. They are of concrete, with crowned bottoms. The pits drain longitudinally, the entire plant being drained to 40 and 50-ft. wells to natural fissures in the underlying rock, leading eventually to the Schuylkill River. All pipes and electric cables enter the building from the power-house in a large tunnel, the location of which beneath the shop floor is indicated in the large plan. This will be illustrated in detail later. In the main tunnel the cables are placed in conduits of vitrified clay. This main tunnel extends across the shop, to carry the piping to fanhouses on the west side. Smaller tunnels open

NILES CRANES IN NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.

Location in Shops.	Number of Cranes.	Capacity, in Tons.	Span, in Feet.	Lift of Hook, in Feet.	Number of Trolleys.	Number of Motors.	Motors—Horse-power. Main Hoist.	Trolleys.	Bridge.	Auxiliary.	Speeds in Feet Per Minute. Main Hoist. Loaded.	Light.	Trolleys. Loaded.	Light.	Bridge. Loaded.	Light.	Auxiliary. Loaded.
Erecting	2	120	69	30	2	6	44	10	44	21	8	20	50	80	150	200	50 (3-ton hoist)
Erecting	2	35	64	28	2	5	21	3	21	..	12	30	80	130	175	225	..
Boiler	1	35	64	28	2	5	21	3	21	..	12	30	80	130	175	225	..
Machine	1	10	55 ft. 10 in.	27 ft. 5 in.	1	3	21	3	21	..	15	35	100	150	200	250	..
Smith	1	10	56	23	1	3	21	3	21	..	15	35	100	150	200	250	..
Foundry	1	10	56	28	1	3	21	3	21	..	15	35	100	150	200	250	..



DETAILS OF COLUMNS AND TRACK SUPPORTS FOR CRANES.

NEW LOCOMOTIVE SHOPS AT READING.—PHILADELPHIA & READING RAILWAY.

into the main tunnel and extend the entire length of the shop on both sides at the inner ends of the locomotive pits. Cast-iron cover-plates are placed over the tunnels at intervals indicated in plan. Each pit is supplied with water and air piping, all of which is protected and out of the way, yet entirely accessible.

Excellent crane service is provided, the shop being sufficiently high for the double-deck arrangement on the erecting-shop sides. For convenience the general features of the various cranes in this shop are condensed into the table on page 56.

As explained in the previous article, the lower crane runways of the west side erecting-shop bay extend over a dwarf wall into the boiler shop. The boiler-shop 35-ton crane, or that of the erecting shop of the same capacity, may be run from one shop into the other—a most convenient arrangement, but one which is advantageous chiefly for the west bay.

An excellent idea of the appearance of the interior of this building was given by the large photograph on page 11 of our January number. A generous area of glass in the windows and roofs gives a uniform distribution of natural light. The floors are entirely unobstructed by anything that will interfere with the use of the valuable floor space or with the cranes. In the engravings just referred to will be found cast-iron racks with wide cross-arms to support cabs, while below these are other arms for the storage of pipes, rods and other fittings, to keep them off the floor. This view also shows the method of supporting the group motors upon cast-iron brackets. Other brackets, of steel plate, extend from the intermediate columns

toward the center of the machine shop to support the shafting.

At the northwest corner of the locomotive shop is the cleaning pit, in a small building reached by the end track of the large shop. This building is shown in engravings which are intended to be so complete as to be self-explanatory.

Seven fanhouses outside of the shop provide for the heating fans, which are driven by induction motors connected by chains. The underground air-ducts serve as intakes for the fans, taking air from openings under each window and conducting it to the fanhouses. The fans deliver the air directly into the shop through large rectangular openings through the walls, and without the usual distributing conduits, the heated air being delivered into the shop through seven large openings. This shop is provided with four washrooms of lean-to construction, located over the fan-ducts and adjacent to fanhouses.

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Extension of the "BD" Method to Compound Locomotives.

BY LAWFORD H FRY.

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$$\frac{\text{Maximum cylinder tractive effort} \times \text{driving wheel diameter}}{\text{Heating surface}} \quad (1)$$

This quantity was called "BD," B representing the ratio of cylinder tractive effort to heating surface, and D representing the driving-wheel diameter. The previous article analyzed the value of this capacity factor BD in the comparison of single-expansion locomotives, and it is now proposed to extend the analysis to cover compounds.

In estimating the value of any constant of comparison, such as "BD," two points are important, viz: that the constant shall be determined by the minimum of calculation and that the results obtained from its application shall have the maximum of accuracy. The capacity factor "BD" has claims for reasonable consideration on both of these points, and in addition it harmonizes well with the commonly used ratios of adhesive weight to cylinder tractive effort, and of heating surface to grate area. These two ratios bring under consideration the four fundamental factors of the locomotive:

1. Adhesive weight.
2. Cylinder tractive effort.
3. Heating surface.
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As the ratios of the first of these dimensions to the second and of the third to the fourth are in common use in measuring the proportions of locomotives it seems only natural to inquire whether the ratio of the second to the third will not serve as the required measure of the relation existing between the heating surface and the cylinder power. Investigation of this question shows that the ratio of the cylinder tractive effort to the heating surface (ratio denoted by B) multiplied by the driving wheel diameter (D), that is to say the factor "B D," gives for every locomotive a constant of the proper form to stand as a measure of the important relation of heating surface to cylinder power. As stated above, this relation determines the steaming power of the locomotive and the quantity "B D" may therefore be called the steaming capacity constant or capacity factor of a locomotive.

The exact analysis of the quantity B D and the figures obtained from actual engines of all classes show that a locomotive having a low value of the capacity factor "B D" is suitable for high speed service, while a high value of the capacity factor points to the locomotive having been designed for low-speed service. Or interpreting the figures in another way: if two or more locomotives are running at the same speed and under similar cylinder conditions, a locomotive with a high value of the capacity factor "B D" will be working at a high rate of evaporation, that is, under less economical conditions and with a smaller margin of reserve power than a locomotive with a lower value of the capacity factor. At equal speeds and under similar cylinder conditions the rates of evaporation are proportional to the respective values of the capacity factor "B D." The speed referred to here is the rate of rotation of the driving wheels (revolutions per minute) and it is interesting to note that when the linear speeds (miles per hour) are the same the rates of evaporation are then proportional to the respective values of the ratio B.

Before going further it may be well to emphasize the fact that a high value of the capacity factor B D indicates a low steaming capacity, so that for free steaming a low value of the factor is desirable. It may be thought that it would have been better to have chosen a factor which was directly proportional to the steaming capacity instead of using the factor B D, which is inversely proportional to the capacity. This would, however, add to the amount of calculation required in determining the factor from the dimensions, or would involve the use of a factor which was a very small decimal. The factor B D was therefore suggested, and when once its meaning has been grasped it does not seem that there need be any particular difficulty in remembering that a low value of the factor B D indicates a large steaming capacity, and *vice versa*. The exact relations existing between the value of "B D," the rate of evaporation, the cylinder economy, and the speed will be shown by the following analysis.

Take the case of a locomotive, either compound or single expansion, running steadily, all the steam produced by the boiler being consumed by the cylinders. Then if the boiler has S square feet of heating surface and the rate of evaporation is b pounds of water per square foot of heating surface per hour, the total hourly evaporation is b S pounds of water. Let the engine be running at r revolutions per minute, corresponding to V miles per hour, and let the available cylinder tractive effort be p T, where T is the maximum available cylinder effort as calculated by the usual formula and p is a percentage factor, which is dependent on the speed and which reduces the available tractive power as the speed increases. Then the available horse-power developed is $\frac{pTV}{375}$, or putting $\frac{rD}{336}$ for V, the expression for the horse-power becomes $\frac{pTrD}{126,000}$, and if the locomotive consumes h pounds of water per available horse-power per hour, the total hourly consumption is $\frac{pTrDh}{126,000}$ pounds of water. Then equating this with the expression found for the total hourly evaporation

$$bS = \frac{pTrDh}{126,000}$$

and collecting to the left-hand side of the equation those terms consisting of dimensions of the locomotive

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By means of this expression the statements made above in regard to the properties of "B D" can be substantiated.

The value of p, that is the percentage of the maximum cylinder tractive effort which is available at the speed r, falls as r increases, but the rate of variation depends largely on the type of cylinders, and on the cut-off at which the engine is worked. In the case of compound cylinders the fall of p with increasing speed is much less rapid than with single expansion cylinders. The report of the American Railway Master Mechanics' Association for 1897 gives much information with regard to the relation between r and p at various cut-offs. Under ordinary running conditions the value of the product p r (and hence the horse-power of the locomotive) increases with the speed r. Now, from expression (2) it is obvious that for the same speed and cylinder conditions (p, r and h constant) the rate of evaporation b is directly proportional to the capacity factor "B D," so that of two engines under similar conditions that engine having the lowest capacity factor will be working with the lowest rate of evaporation, that is to say, under the most favorable boiler conditions. For locomotives which are to work at the same speed and with similar cylinder conditions a low value of the capacity factor represents to free steaming and a good margin of reserve boiler power. Further, in the case of locomotives with similar cylinders the water consumed per horse-power per hour (h) will be dependent on the cut-off rather than on the speed, so that with the same cut-off and the same rate of evaporation (h and b constant) the locomotive with the lowest value of B D will be capable of the highest speed. This follows from expression (2) and is very clearly confirmed when the figures for actual locomotives are examined. The results of compiling a number of such figures are shown in Table 1. In the AMERICAN ENGINEER for October, 1902, page 314, were given the results of an examination of the values of the capacity factor "B D" for 79 single-expansion locomotives, and to these are now added the figures for 45 Vauclain four-cylinder and 28 two-cylinder, in all 73, compound locomotives.

In analyzing these figures it was necessary to separate the locomotives according to the speed for which they were designed. This was a somewhat difficult problem, and the method adopted can only be considered approximate. The engines have been grouped according to the arrangement of their wheels. Prairie, Atlantic, and American (2-6-2, 4-4-2, and 4-4-0) type engines have been classed as high speed, while Consolidations, Mastodons, and Moguls (2-8-0, 4-8-0 and 2-6-0) are classed as low speed, the ten-wheelers (4-6-0) having the medium place.

Objections may be raised to this method of grouping, and it is certainly not perfect, as many of the 10-wheelers have been designed for high speed service, but after due consideration it seemed to have fewer disadvantages than any other method which suggested itself.

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Both Types Compound...	Fast	10	670	497	602
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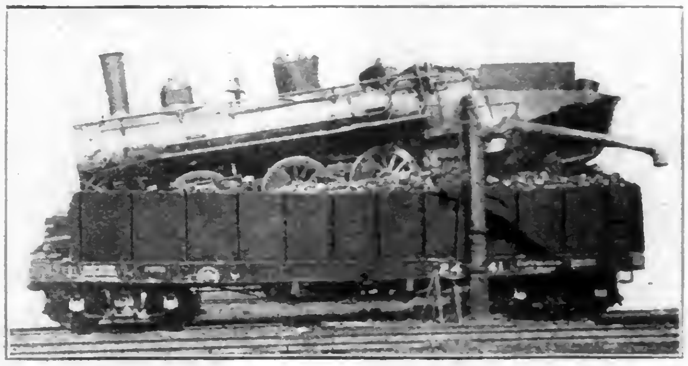

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

Notwithstanding the fact that we printed more copies of the January number than of any previous issue of this journal, the edition was almost entirely exhausted at the middle of January. We are sorry that many of the new subscriptions for the year 1903 must necessarily begin with the February issue.

This journal has the honor of printing in this issue the first article of a comprehensive series from the pen of Mr. R. H. Soule upon the subject of the modern railroad shop. the presentation of which will require at least a year. Mr. Soule has no superior as an authority on this subject. He is fitted to discuss it by technical training as a mechanical engineer, by an experience of seventeen years in motive-power service, and also by close contact with recent developments in having been retained as consulting engineer in planning a number of large new shops on some of the most important trunk lines. Our readers will remember that he also designed the shops of the Buffalo, Rochester & Pittsburgh Railway, illustrated in our April and May issues of last year. This journal and its readers are fortunate in having the opportunity to study shop problems which this treatise by Mr. Soule promises to afford. We desire to stand for the practical application to railroads of the principles which underlie commercial success, and it is confidently believed that this work will not only be valuable as a study of shop problems, as a record, and a guide to future practice, but that it will exert a powerful influence in the intelligent treatment of what has become one of the greatest engineering and business questions with which railroad officers of the present time have to deal. The articles cannot fail to bring in a new era in railroad-shop construction, the influence of which is expected to extend far beyond the limits of the subject treated. Such a work as this has never before been attempted, and it can only be properly undertaken by one having the qualifications and attainments of Mr. Soule.

The increase of output of machinery driven by electric motors is the great desideratum which is achieved by the application of direct-connected motor drive, and far outweighs in importance the several other advantages incidental to this method of driving—the saving of head room, for example, the absence of long lines of shafting, and the avoidance of power wastes. Indeed, the value of the power, whether furnished by shafting or by the electric motor, as compared with the importance of the increased product, is nearly negligible.

It is encouraging to note the efforts now being made to devise a satisfactory system of comparing locomotives of various designs in order to make a study of the factors which go to make up capacity for sustained power. In this issue will be found a suggestion from Mr. E. L. Coster, which is believed to be new and seems to be excellent. Briefly stated, Mr. Coster suggests expressing the heating surface in per cent. of the total maximum tractive power. This is an important subject and correspondence from our readers is invited.

The actual limitations and shortcomings of the older styles of machine tools seriously hamper them in meeting the demands of these modern times—probably no one particular is found, in establishing piece-work rates, to involve a greater waste of time than that of changing driving speeds and feeds on, and otherwise adjusting, machine tools, especially of the older models, and this is the great factor that prevents so many machine shops equipped with old styles of tools from successfully competing with piece-work shops equipped with modern tools. This criticism applies, of course, only to machine tools of the older styles; the machine tool manufacturers of to-day in this country are to be given credit for their commendable progress, and may be said to be well abreast of

the times. But it is in this respect that our present old-established railway repair shops are open for great improvements with the respect to the cost of doing work; careful attention to points of feeds and speeds of driving above mentioned will, when purchasing new machines, provide for great reductions in the times required for certain machining operations from what would be required on the old style plain machines.

It is evident that railroad officers appreciate the necessity for improved facilities for handling and storing coal for locomotive use, the cost of this service with poor facilities having attracted attention. Of late a large number of improved chutes have been built and in nearly every case the item of labor expense in handling the coal has been very carefully considered. A low cost of handling is, however, not the only important consideration in this equipment; in fact, it is not the most important one. There is serious danger of throwing to the winds the coal records of the enginemen, and this has not been considered at all in coal chute construction on several leading roads during the past year or two. If a coal chute does not provide means of knowing how much coal is delivered to each engine it cannot be considered satisfactory or complete. Coal records never have been and cannot be satisfactory in their effects upon the economy of consumption unless the coal is actually weighed at the chutes. This is the opinion of motive power officers, and it should be considered by officers of other departments who have to do with the construction of this equipment. It is difficult to state the value of weighing facilities, but it is safe to measure it by that of coal records themselves; because records based upon anything except actual weight are ineffective.

The entire fuel question might profitably be placed in the hands of a competent man, having the necessary knowledge and experience and authority to advise and direct in all matters pertaining to coal, from its purchase to its consumption. In fact, the important character of the fuel question on large roads already demands such treatment.

Almost everyone who has had to do with the setting of piece-work prices has been disconcerted by comparing the time a workman has taken to do a certain piece of work with the theoretical time that had been figured out for it. The usual plan has always been, when setting a piece-work price, to carefully calculate the amount of surface to be machined, and then by allowing certain cutting speeds and rates of feed, the theoretical time it should take to remove the material is arrived at. To such time is added what is considered necessary for setting the work, changing the tools, etc; but in most instances the line of variation between theory and practice is, to say the least, confusing. On investigation it is invariably found that it has been omitted to allow for time lost in playing round and fiddling with the machine itself—taking ten minutes to alter this feed, five minutes to alter that motion, and so on. If a machine is to be bought for any work that requires certain definite machining, why not calculate theoretically the time required to do the work, and put this time down as the maximum efficiency. If then you are going to purchase a tool for doing that work, why not set this time down in your specification and get makers to state what percentage of efficiency they will guarantee on your time? The day has gone past when a good tool means merely a machine well and solidly built, and capable of doing first-class work. The element of "time efficiency" is now the important clause in the contract. What use is it to a manufacturer if he has a number of splendid tools made by first-class makers and capable of doing good work at the end of the next century if his neighbor is equipped with a plant which enables him to undersell by 25 per cent.?

RAILWAY SHOPS.

By R. H. Soule.

I.

INTRODUCTORY.

The arrangement and proportions of railway shops constitute a problem which is demanding careful consideration at the present time, and which is certain to increase in future importance. This condition is largely due to the change from a period of depression to a period of unparalleled prosperity during the last ten years. At the beginning of that period railway managers were enforcing the most drastic measures of economy, and officers in charge of shops effected surprising reductions in operating expenses which came under their supervision or control. Every line of disbursement of either labor or material was relentlessly followed up, and savings insisted upon. What was accomplished by this crusade is a matter of history; it was the greatest lesson in economy that shop officers had ever enjoyed. Then gradually came the increase of business which has culminated in present conditions, which make such unprecedented demands on railway shops that maximum output has been forced to the front as an absolute requirement. This chain of circumstances has therefore emphasized economy and output as the elements of prime importance in the operation of railway shops. Up to the time of this awakening there prevailed on most lines a comfortable complacency and satisfaction in things as they were; this feeling has now given way to a determination that existing shop plants shall be modernized, and that all new plants shall be so proportioned, arranged, equipped and organized as to meet present-day requirements as regards economy and output. This necessity for more careful work in shop design has also been stimulated by the fact that the continued merging of railways into great systems has justified larger outlays of capital for the purpose of establishing central repair and construction plants.

In approaching the problem of designing a central shop plant the fact stands out that the problem is a very complex one, and as it is pursued to completion the details multiply. It involves the proper provision of space, power, tools and appliances for all the varieties of labor which are concerned in the construction or repairs of locomotives and cars, passenger and freight. To establish such facilities in proper proportion to one another requires that many assumptions must be made, involving the relative amount of work of the several classes which is to be done. Such assumptions are apt to be faulty, owing to the fact that traffic conditions change frequently and quickly on most railways. It is for that reason that many railway shop plants have had to be modified in certain particulars after having been occupied and used a year or two. But, nevertheless, such preliminary assumptions must always be made, and the fact that they are apt to be misleading affords the strongest argument for adopting them only after the most careful consideration. The variety of classes of labor to be provided for is very great, but there is no department of a railway which has to handle so many varieties of material as the motive power department. A count of items on the semi-annual inventories of an Eastern line, some two years ago, showed that the maintenance of way department used about five hundred varieties of shapes, sizes and materials, while the motive power department used about five thousand. A modern shop must provide for the proper housing, classification, handling and distribution of these materials.

New and modifying influences have also crept into the shop problem from the outside. The practical and successful application of electricity as an agent for distributing and applying energy, whether for power or for lighting purposes, has dis-

credited old and well-understood systems. The relative merits and the line of demarkation between the legitimate use of direct current and alternating current apparatus being a matter on which even the electrical experts fail to agree, the shop designer must proceed with the utmost caution. Several different methods of motor speed control are advocated, and apparatus with this object in view appears to be multiplying. The conflicting claims of circuits for power and for lighting, as between direct and alternating currents, must be met, considered and perhaps compromised.

New tool steels of increased cutting power have upset the traditions of feeds and speeds for machine tools, and the intelligent use of such steels has increased the output per tool. Both humane and business considerations call for the most improved methods of heating, ventilating and lighting buildings. With electrical distribution there is no need or justification for small isolated units of power, and the central power plant assumes first importance as the one source of energy, whether used for power, lighting or heating; power being distributed as electricity, compressed air, or fluid under pressure (hydraulic power); lighting being accomplished by either arc or incandescent lamps, and heating being effected by either exhaust or live steam. Various types of boilers being available a selection must be made with due regard to both first cost and economy of maintenance. The engine equipment must be chosen not only as regards type and economy, but must be subdivided into such units as can be combined to the best advantage in order to secure the greatest possible efficiency under a varying total load. The cost of coal and water supply will determine the choice as between condensing and non-condensing engines, as well as between simple and compound. The gas engine is a close competitor with the steam engine on the score of thermal efficiency, and the day may not be far distant when a gas producer plant may be needed instead of the boiler plant, as a basis of power supply. Coal being the accepted fuel, whether for use in generating steam or producing gas, provision should be made for storing and handling the supply, and handling and removing ashes, with the least expenditure of labor. The problem of draft requires close analysis of conditions before choosing between the tall chimney and the short, the latter to be supplemented by mechanical appliances for inducing draft. To determine the gross amount of power to be provided at the central station it is necessary to prepare charts showing what is likely to be the load for each department of the shops or each class of service for each hour of the day, and from such separate or individual charts prepare a total load chart, from which the desired maximum can be deduced. It is not probable that the storage battery will be much used as an adjunct to railway shop power plants as the total load does not ordinarily fluctuate between such wide limits as in central stations where electric energy is supplied for traction or for lighting purposes.

These facts indicate that the power plant is a complex problem, but nevertheless it is a problem of such a nature as to be susceptible of treatment by well understood engineering methods. On the other hand, the problem of the proper proportions of the buildings to be occupied by the different departments of a railway shop, and their proper grouping and spacing cannot be solved by appealing to any existing formulæ, but only by an intelligent analysis of recent examples of what are believed to be the best practice under conditions approximating those which exist to-day. This analysis should not fail, however, to recognize defects, if such exist, in shops which in general are thoroughly modern.

It will no doubt be possible by this process to deduce certain constants, factors, and ratios which may be available for future use, and this inquiry is made with that object in view. Where alternative arrangements or methods are found in practice their relative merits will be discussed.

(To be continued.)

A PREMIUM PLAN FOR TRAVELING ENGINEERS.

The Chicago Great Western has a plan, with reference to locomotive coal records, which is worthy of general adoption. Coal records are carefully kept, the chute reports being sent daily to the superintendent. Coal allowances are made for each class of engine and each kind of service as follows:

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The traveling engineers are paid a certain guaranteed minimum salary and their actual rates per month are based upon the per cent. of excess made by the engines on the divisions with which they are connected. The traveling firemen receive a rate which is proportionate to that of the traveling engineer of the same division. Of course these allowances must be very carefully determined and the grades, speeds and character of the locomotives must be considered. They would vary greatly on different roads. For the Chicago Great Western Mr. Van Alstine has prepared a schedule for each division giving the rates of pay per month for various percentages of excess. The plan has been in effect since May 1, 1902, and is reported to be schedule given here has been in effect since May 1, 1902, and is reported to be very satisfactory. The original plan of making allowances per 10,000-ton miles for each train, or class of trains, has been in effect on this road for over ten years. Traveling engineers were put on about two years ago and soon after were placed on the premium basis.

The application of electric traction to heavy traffic on present steam roads is settling itself in a natural and interesting way, and it is to be introduced because of conditions which cannot be met by steam locomotives. In the improvements of the New York Central terminal and the entrance of the Pennsylvania into New York City will be seen the first entrance of electricity on a large scale into the field of heavy transportation service. The real beginning was made in the Baltimore & Ohio tunnel, but the present schemes will open a new epoch in electric transportation. On the New York Central all suburban trains from Croton, on the main line, and White Plains, on the Harlem division; on the New York, New Haven & Hartford all suburban trains from a point yet to be determined, and on all three lines all passenger trains, from whatever distance, will be drawn into the Grand Central station by electric motors. This, together with the contemplated changes in the station itself, will cost about $25,000,000 and the electric installation will be the largest ever considered. Little can be said as yet concerning the extent of the electric work on the Pennsylvania terminal, but it will be great, and the extension of electric traction on Long Island and toward Philadelphia will follow as a matter of necessity. It seems perfectly reasonable to expect the Pennsylvania to ultimately use electric motors for all its passenger traffic between New York and Philadelphia as a natural growth of the application in the tunnel and at the new terminal. Without an attempt to forecast the future, its present plans are sufficiently great to center the attention of engineers and railroad officers for several years, and there can be no question of the fact that there is more heavy electric work to come. These problems involve new questions for which there are no precedents. It is a matter of the greatest interest to railroads to be prepared to meet these new problems, and a noteworthy incident to the situation is the opportunity which it offers to young men who combine abilities in railroad and electrical work.

PASSENGER LOCOMOTIVE — NORTHERN PACIFIC RAILWAY.

4—6—2 TYPE.

BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.

This type of wheel arrangement seems to be likely to become popular. There seems to be a rather persistent impression that a two-wheel leading truck is less satisfactory than one having four wheels, but, as far as we know, it has not been demonstrated that the two-wheel truck is in any respect deficient. This is a very large and powerful passenger engine which has not been exceeded in heating surface except by a very few examples in previous practice, as the table in our issue of last June indicates. The Missouri Pacific locomotives of the same type, illustrated in September of last year, were somewhat larger in this respect, while being also lighter in total weight. The figures of the two designs furnish an interesting comparison. The Northern Pacific has been very favorable to compounds, experience on that road having been satisfactory. It is not understood that this departure indicates a decided adverse step with reference to them. This engine has piston valves with inside admission, frames having a single bar at the cylinders and slabs at the firebox, and the trailing truck is of the Player type used on a number of locomotives built at the Brooks Works of this company, but in this case its construction has been somewhat changed, as will be indicated in a later article. It was the intention to present at this time a number of the details of this locomotive, but because of the space required for other purposes these will be presented later. The following ratios and table of dimensions present the leading features of the design, of which about 50 engines have been built. Specially interesting features of the construction will be presented in another article:

RATIOS.

Tractive power = ...31,000 lbs.

(1) $\frac{\text{Heating surface}}{\text{Cylinder volume}}$ = ... 302

(2) $\frac{\text{Tractive weight}}{\text{Heating surface}}$ = ...38.7

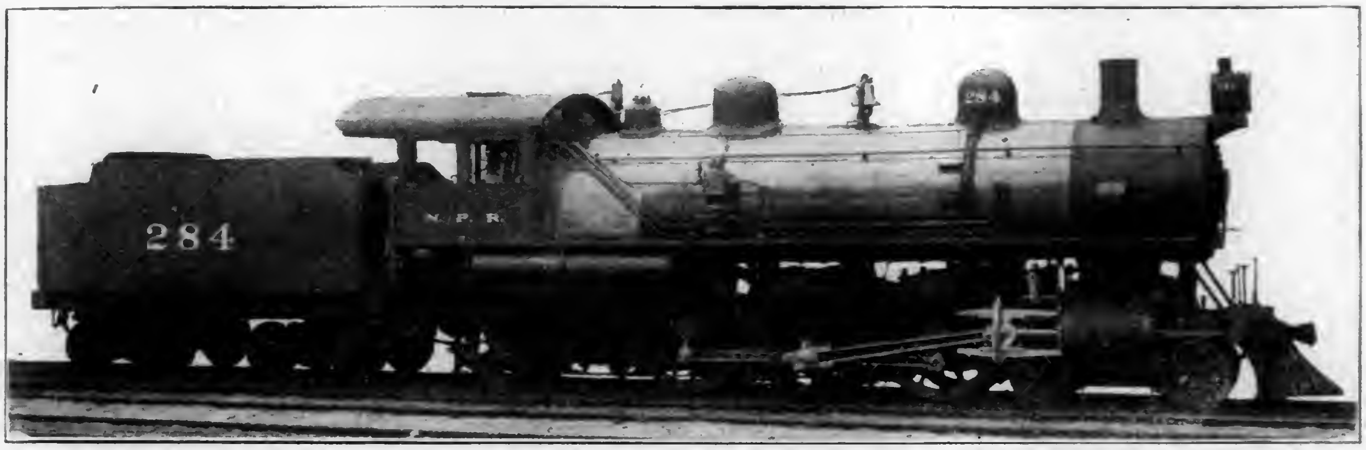
(3) $\frac{\text{Tractive weight}}{\text{Tractive effort}}$ = ...4.32

(4) $\frac{\text{Tractive effort}}{\text{Heating surface}}$ = ... 8.9

(5) $\frac{\text{Heating surface}}{\text{Grate area}}$ = ...73.7

(6) $\frac{\text{Tractive effort} \times \text{diameter of drivers}}{\text{Heating surface}}$ = ... 614

(7) Heating surface in per cent. of tractive power = ...11%



PASSENGER LOCOMOTIVE, 4—6—2 TYPE, NORTHERN PACIFIC RAILWAY.

A. E. MITCHELL, *Superintendent Motive Power*. AMERICAN LOCOMOTIVE COMPANY, *Builders*.

NORTHERN PACIFIC PASSENGER LOCOMOTIVE.

4—6—2 TYPE.

General Dimensions.

Fuel ....Bituminous coal
Weight in working order..202,000 lbs.
Weight on drivers ....134,000 lbs.
Weight engine and tender in working order..............325,400 lbs.
Wheel base, driving ....12 ft.
Wheel base, rigid ....12 ft.
Wheel base, total ....33 ft.
Wheel base, total, engine and tender..................58 ft. 4½ ins.

Cylinders.

Diameter of cylinders ....22 ins.
Stroke of piston ....26 ins.
Horizontal thickness of piston..5½ ins.
Diameter of piston rod..4 ins.

Valves.

Kind of slide valves..Piston type
Greatest travel of slide valves..6 ins.
Outside lap of slide valves..1 in.
Inside clearance of slide valves..⅛ in.
Lead of valves in full gear:
Line and line in full gear, forward, ¼-in. lead at 6½ ins. cut-off

Wheels, Etc.

Number of driving wheels..6
Diameter of driving wheels outside of tire..................69 ins.
Material of driving wheels.........Centers, cast steel; centers, 62 ins.
Thickness of tire ....3½ ins.
Driving box, material ....Cast steel
Diameter and length of driving journals,
9½ ins. and 9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals,
Main side 7¼ ins. x 4¾ ins., 7 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals,
5ins. diameter x 4½ ins.
Engine truck, kind........................Four-wheel, swing bolster
Engine truck, journals....................6 ins. diameter x 11 ins.
Diameter of engine truck wheels..33 ins.
Kind of engine truck wheels..................Steel tired spoke center

Boiler.

Style ....Straight
Outside diameter of first ring..70 9-16 ins.
Working pressure ....200 lbs.
Thickness of plates in barrel and outside of firebox,
25-32 in., 13-16 in. and 9-16 in.
Firebox, length ....90 3-16 ins.
Firebox, width ....75⅝ ins.
Firebox, depth ....Front, 78½ ins.; back, 66 ins.
Firebox plates, thickness:
Sides, 5-16 in.; back, 5-16 in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space....Front, 4½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes, number 301
Tubes, diameter ....2¼ ins.
Tubes, length over tube sheets..................................18 ft. 6 ins.
Firebrick, supported on..............................Four water tubes
Heating surface, tubes ....3 264.3 sq. ft.
Heating surface, water tubes..23.02 sq. ft.
Heating surface, firebox ....175.1 sq. ft.
Heating surface, total ....3,462.42 sq. ft.
Grate surface ....47.2 sq. ft.
Exhaust pipes ....Single
Exhaust nozzles ....5¼ ins., 5½ ins. and 5¾ ins. diameter
Smokestack, inside diameter ....18 ins.
Smokestack, top above rail ....14 ft. 10¾ ins.

Tender.

Style ....Eight-wheel
Weight, empty ....49,400 lbs.
Wheels, number 8
Wheels, diameter ....33 ins.
Journals, diameter and length..............5½ ins. diameter x 10 ins.
Wheel base ....17 ft. 2 ins.
Tender frame ....Steel channels
Water capacity ....6,000 U. S. gals.
Coal capacity ....12 tons

credited old and well-understood systems. The relative merits and the line of demarkation between the legitimate use of direct current and alternating current apparatus being a matter on which even the electrical experts fail to agree, the shop designer must proceed with the utmost caution. Several different methods of motor speed control are advocated, and apparatus with this object in view appears to be multiplying. The conflicting claims of circuits for power and for lighting, as between direct and alternating currents, must be met, considered and perhaps compromised.

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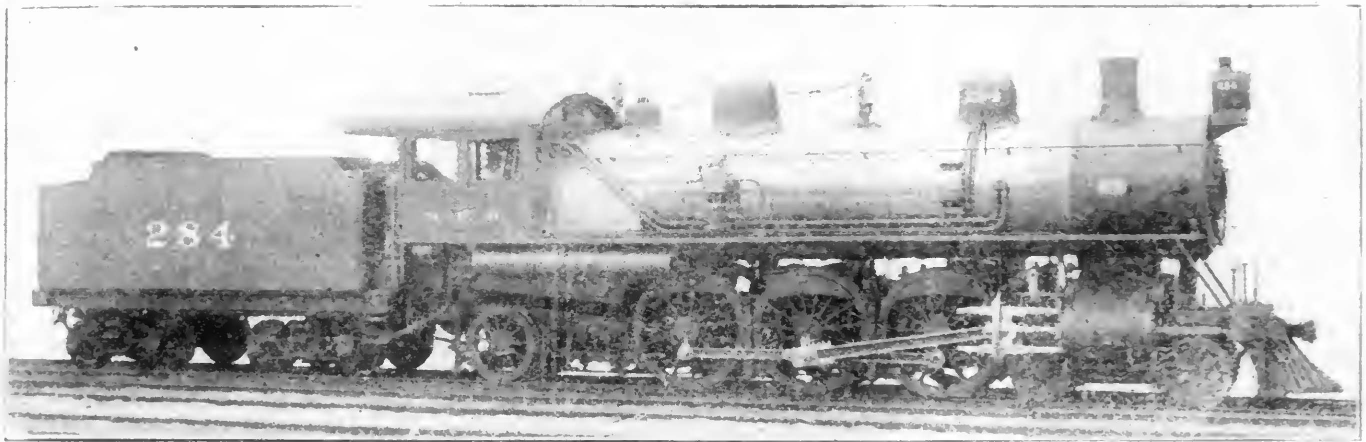

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Tractive weight / Tractive effort	4.32
Tractive effort / Heating surface	8.9
Heating surface / Grate area	73.7
Tractive effort × diameter of drivers / Heating surface	611
Heating surface in per cent. of tractive power	11

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General Dimensions.

Fuel	Bituminous coal
Weight in working order	202,000 lb.
Weight on drivers	134,000 lb.
Weight engine and tender in working order	327,400 lb.
Wheel base, driving	12 ft.
Wheel base, rigid	12 ft.
Wheel base, total	[illegible]
Wheel base, total, engine and tender	[illegible]

Cylinders.

Diameter of cylinders	[illegible]
Stroke of piston	[illegible]
Horizontal thickness of piston	[illegible]
Diameter of piston rod	[illegible]

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	[illegible]
Outside lap of slide valves	1 in.
Inside clearance of slide valves	[illegible]
Lead of valves in full gear: Line and line in full gear forward [illegible] lead [illegible] cut off	

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	69 in.
Material of driving wheels	Center, cast steel; center, 62 ins.
Thickness of tire	3½ ins.
Driving box, material	Cast steel
Diameter and length of driving journals	9½ ins. and 9 ins. diameter × 12 ins.
Diameter and length of main crankpin journals	Main side 7½ in. × 1[illegible] ins.; 7 ins. diameter × 6½ ins.
Diameter and length of side rod crankpin journals	5 ins. diameter × 1[illegible] ins.
Engine truck, kind	Four wheel, swing bolster
Engine truck journals	6 ins. diameter × 14 ins.
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheel	Steel tired, spoke center

Boiler.

Style	Straight
Outside diameter of first ring	70 9-16 ins.
Working pressure	200 lb.
Thickness of plates in barrel and outside of firebox	25-32 in., 13-16 in. and 9-16 in.
Firebox, length	90 3-16 ins.
Firebox, width	75⅝ ins.
Firebox, depth	Front, 78½ ins.; back, 66 ins.
Firebox plates, thickness	Sides, 5-16 in.; back, 5-16 in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 4½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes, number	301
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	18 ft. 6 ins.
Firebrick, supported on	Four water tubes
Heating surface, tubes	3,261.3 sq. ft.
Heating surface, water tubes	23.02 sq. ft.
Heating surface, firebox	175.1 sq. ft.
Heating surface, total	3,462.42 sq. ft.
Grate surface	47.2 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	[illegible] ins., 5½ ins. and 5¾ ins. diameter
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 10¾ ins.

Tender.

Style	Eight wheel
Weight, empty	49,400 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter × 10 ins.
Wheel base	17 ft. 2 ins.
Tender frame	Steel channel
Water capacity	5,000 U. S. gal.
Coal capacity	12 tons

ELECTRICITY IN RAILROAD SHOPS.

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Mr. Pomeroy states that the two great advantages of the direct current, so far as power transmission is concerned, are slow speed, and variable speed on the motor itself. With a slow-speed motor it is possible often to make a sufficient reduction of speed to the normal required by the machine by means of gearing with a motor using a slight variation in field winding, increasing the cost of the motor only about 5 per cent. over standard types; an increase in speed of 25 per cent. above normal may be obtained by field weakening, or 40 per cent. below normal by interposing armature resistance is possible.

While it is not advisable to presume on using the full range of such speed variation continuously, yet in conjunction with the step cones, or back gears, any intermediate speed between the cones or gears can be exactly met. Such speed variation is feasible and practical. This represents the cheapest form of utilizing motor speed variation, from the viewpoint of first cost.

Next in point of cost is the use of a special type of motor, giving 100 per cent. field regulation. By this type of motor the varying requirements of most any tool can be met at a slightly increased cost over constant-speed or standard motors.

By varying the current flowing in the field coils of a motor the strength of the magnetic field is changed and the speed of the motor varied. With any setting of the field the motor will give constant speed under changes of load, and this method, therefore, avoids the greatest objection to rheostatic control.

A motor of ordinary design will not permit of any considerable field weakening, without deleterious sparking at the commutator, but with a special motor having small armature reaction a variation in speed of two to one can readily be obtained, and when delivering a constant horse-hower the current will be approximately the same at all speeds because the potential across the armature terminals is always the same.

Mr. Pomeroy states that mere economy of transmission is one of the least advantages to be gained by electric driving; the cost of power in fuel is so small a part of the total cost of operation that it can be practically ignored, on account of the other advantages and larger savings resulting from the introduction of electric transmission. He estimates the factors which enter into the cost of production at the following average values:

Fuel	3 per cent. of the total cost of the article
Labor	47 per cent. of the total cost of the article
Material	50 per cent. of the total cost of the article

The conclusions of the paper are that electric shop driving permits of a centralized power generation for light and manufacturing purposes; maximum efficiency of workman, machines and labor involved; intensified production at best speeds and at the power limit of machines, with improved quality, maximum output and reduced cost.

The cost of maintenance is a minimum. The depreciation is less than in any other system. The saving effected is much more than sufficient to pay for all the incidental repairs and renewals to the electric machinery or the wiring system. Attendance and supervision can be largely centralized and reduced to a minimum.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

BY C. W. OBERT.

II.

In the preceding article of this series were described two admirable variable-speed positive-drive mechanisms which are applied to the feeds of lathes. In this issue a mechanism of similar character, which has been applied to the Cincinnati milling machine, will be considered. This device belongs to the same general classification of positive-drive mechanisms with the speed range varying through a definite number of steps by the use of gears.

The variable-speed device, applied by the Cincinnati Milling Machine Co., Cincinnati, Ohio, to the feeds of their plain and universal milling machines consists of two separate and distinct mechanisms, one of which transmits the power to the

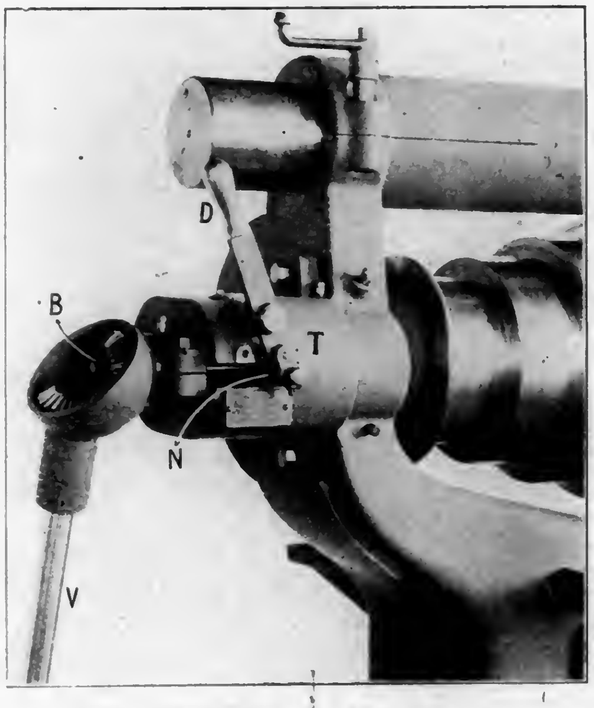

FIG. 7.—FRONT VIEW OF UPPER GEAR BOX.

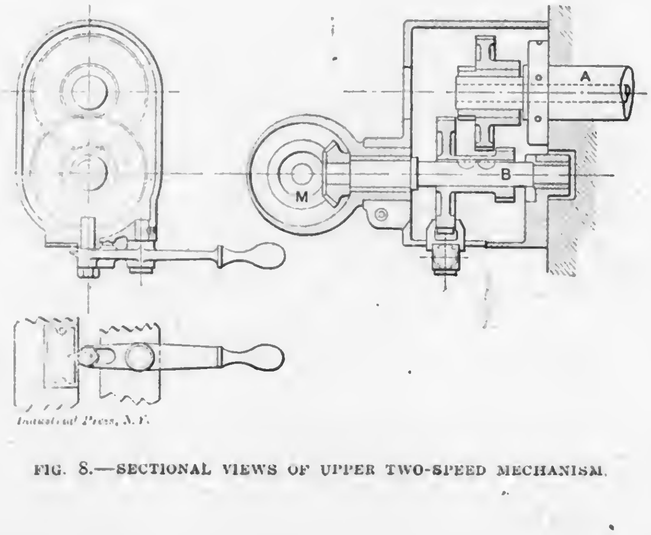

FIG. 8.—SECTIONAL VIEWS OF UPPER TWO-SPEED MECHANISM.

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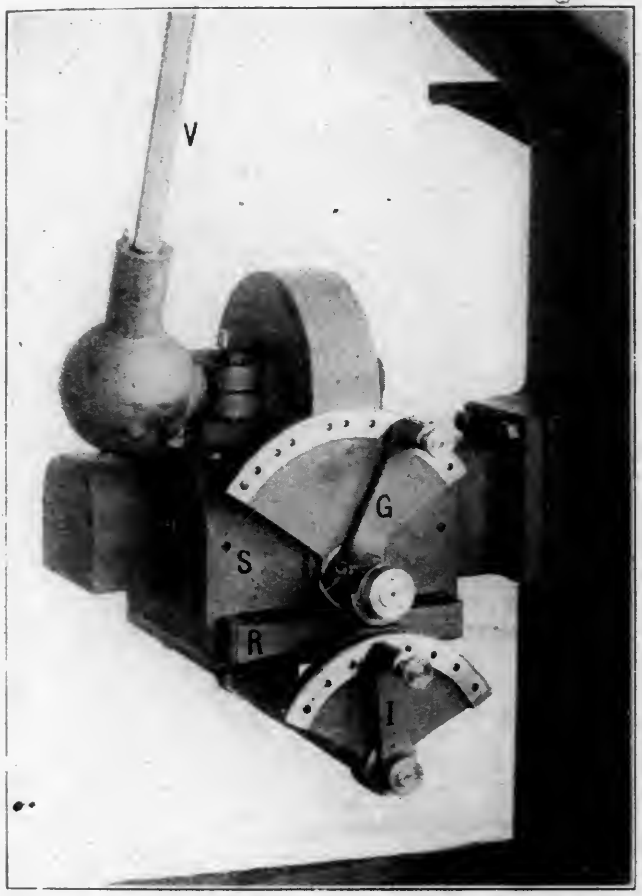
The position of this sleeve and gears is governed by the guide block, N, embracing the larger gear on the shaft, B, so that by moving this guide block through the medium of handle, D, either pair of gears may be brought into mesh. A middle position of the handle and gears, which is the position shown in Fig. 8, clears both pairs of gears out of mesh and thus throws all of the feeds out of gear. This makes two speeds possible with this combination, one giving an increase of speed and the other a decrease of speed, and in the middle position no motion is transmitted.

The eight-speed mechanism, S, is, as was before stated, situated below the two-speed mechanism, receiving its motion from the same through the vertically inclined shaft, V. The motion is received from shaft, V, through another pair of miter gears onto a shaft, C, carrying the two feed gears, Q and U, Fig. 10. Then upon a shaft, O, there are arranged two nests or cones, X and Y, of four gears each, the four gears of each nest being keyed to a sleeve fitting loosely on the shaft, so that either nest may revolve as a solid unit on the shaft independently of the other. These two gear cones are given independent motions by the feed gears, of which the larger



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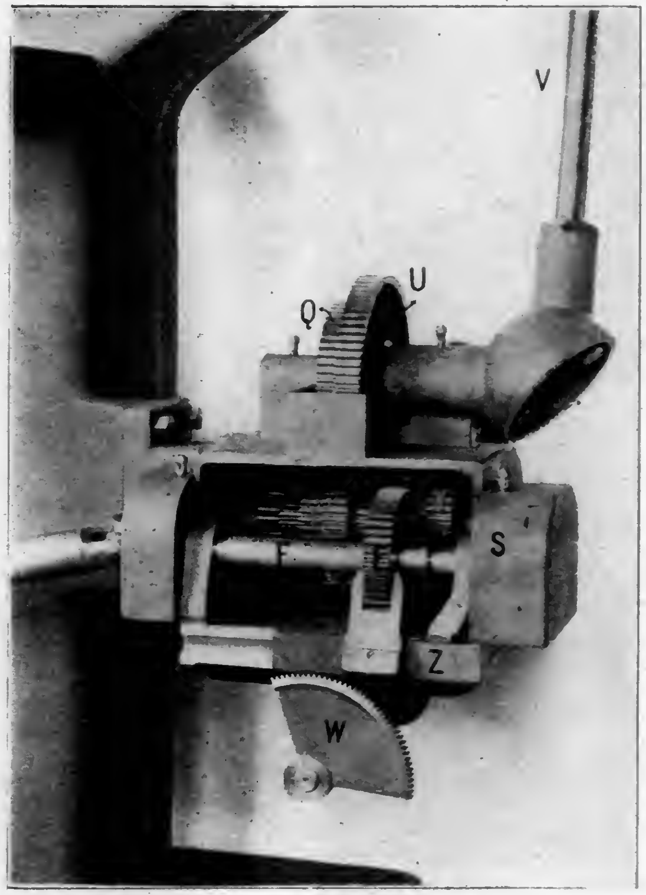
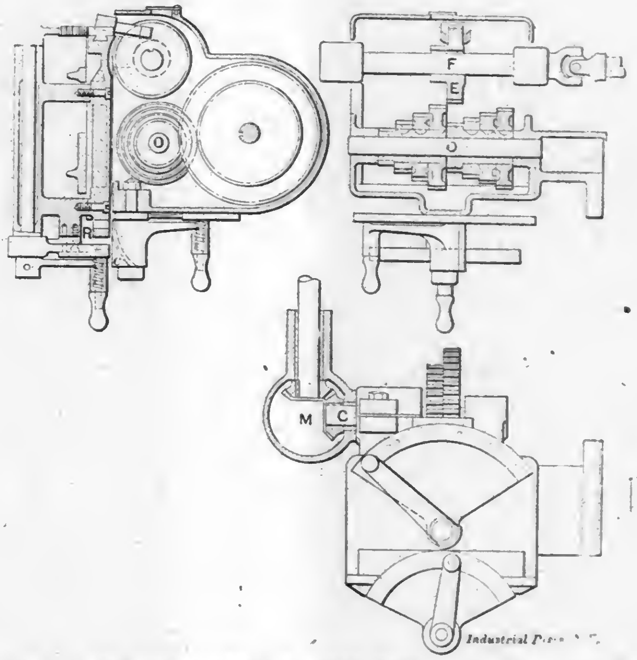


FIG. 10—REAR VIEW OF LOWER GEAR BOX.



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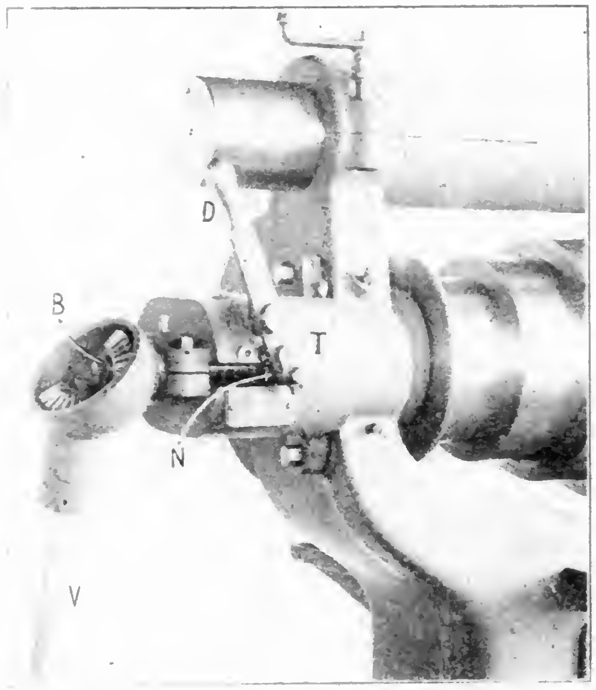

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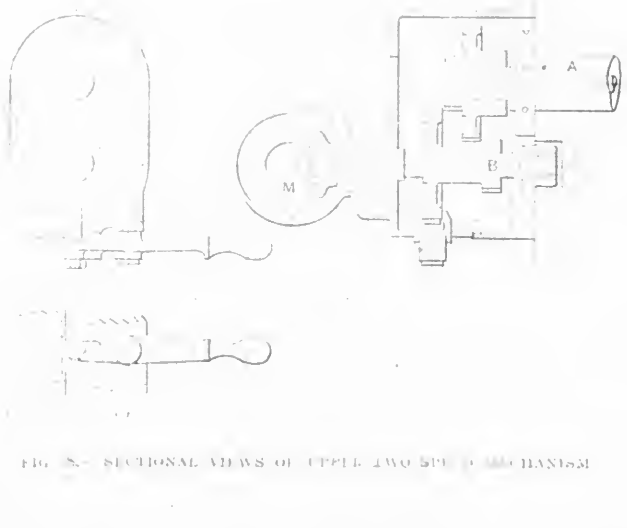

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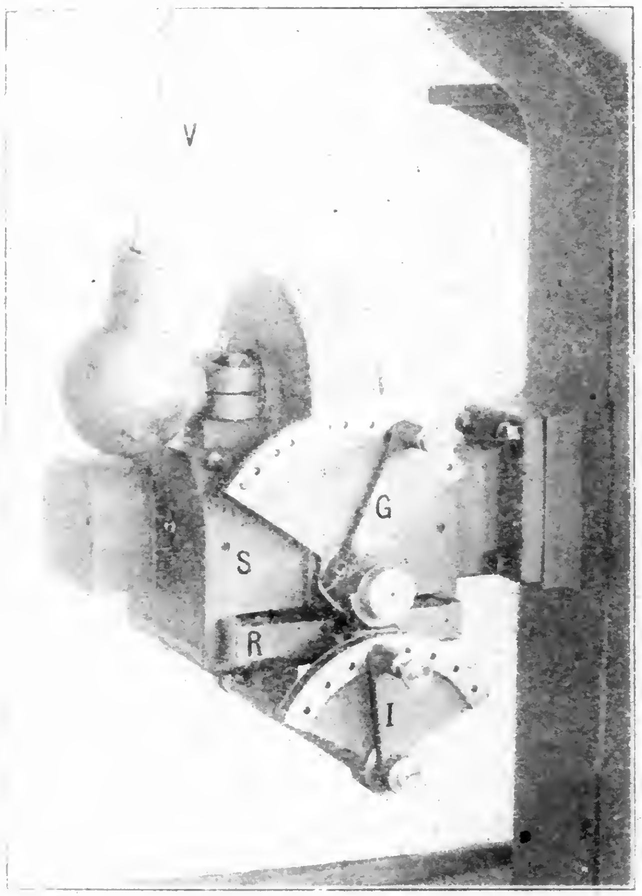

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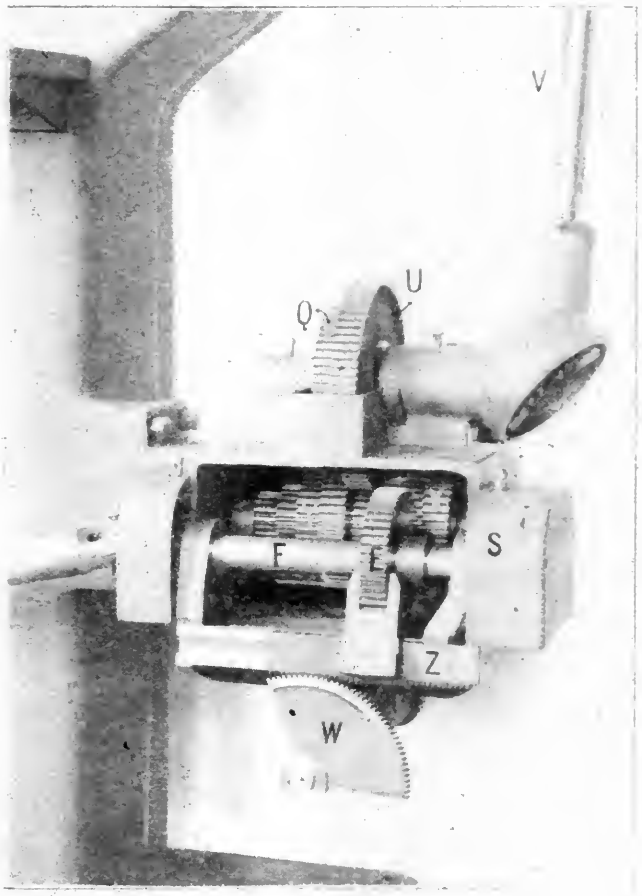

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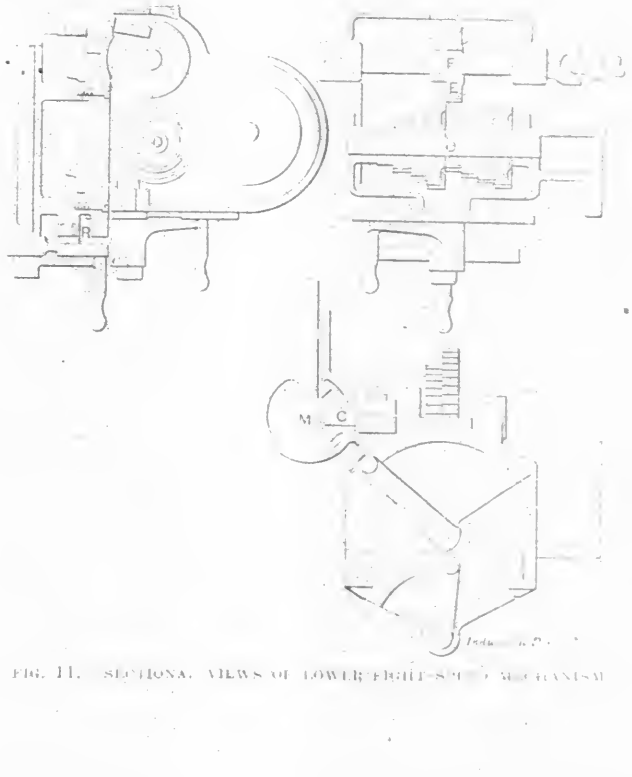


FIG. 11.—SECTIONAL VIEWS OF LOWER EIGHT-SPEED MECHANISM.

gear, U, meshes permanently with the smallest gear of nest, X, giving that nest a relatively high speed, and the smaller gear, U, meshes permanently with the smallest gear of nest Y, giving that nest a relatively slow speed. In this way a wide range of speeds is available, in eight steps, by virtue of the two nests revolving at widely different speeds.

The manner of delivering motion from any one of the gears upon the two nests is very similar to that of the gear box first described in this series, differing mainly in the provision for bringing the receiving pinion, E, up against the cones. This intermediate gear, E, is feathered on the shaft, F, so as to slide along it, and is brought into mesh with any one of the eight cone gears by shifting the two levers, G and I, shown in Figs. 9, 11 and 12. The lower lever, ., moves the gear, E, along its shaft, F, through the medium of a toothed sector, W, which meshes with the rack, Z, upon which is carried the guide block embracing the gear, E.

The proper position of the lever I, for a position of mesh by gear, E, is indicated by the eight holes upon the quadrant at the front into which the lever locks. After the gear, E, has been brought into position for mesh by means of lever, I, it is moved forward into mesh by the lever, G, which does so by moving the entire lower slide, R, of the box up toward the cones, the proper adjustment of this lever for bringing the pitch lines of the gears into coincidence being indicated by holes in its quadrant into which it locks. This movement of the slide, R, with respect to the lever, G, which is mounted on the frame of the mechanism, is accomplished by means of a helical groove, Gr, Fig. 11, on the lower side of its hub which engages with a pin on the upper side of the slide. Power is delivered from the shaft, F, through a feed shaft having universal joint connections to allow for the lateral movement of the slide, R.

Fig. 12 is a general view of the No. 4 universal Cincinnati miller with this gear mechanism applied, the two-speed mechanism being above and the eight-speed mechanism below at the rear. It is so arranged that all levers may be operated from the front, but above all the extreme economy of space, occupied by the complete mechanism for such a variation of 16 speeds possible, is to be noted; since the lower mechanism is capable of delivering eight different speeds, and the upper device may deliver two different speeds to it, the combined mechanism is capable of furnishing 16 different speeds: This device has the paramount advantage of having both of the gear mechanisms entirely closed and thus protected from dirt and injury. It is quite as simple in construction as the devices heretofore mentioned and involves no serious difficulties in its manipulation; while in the manner of design it gives evidence of the application of a great amount of ingenuity and is one of the best examples of applied mechanism to be found among the devices of this type.

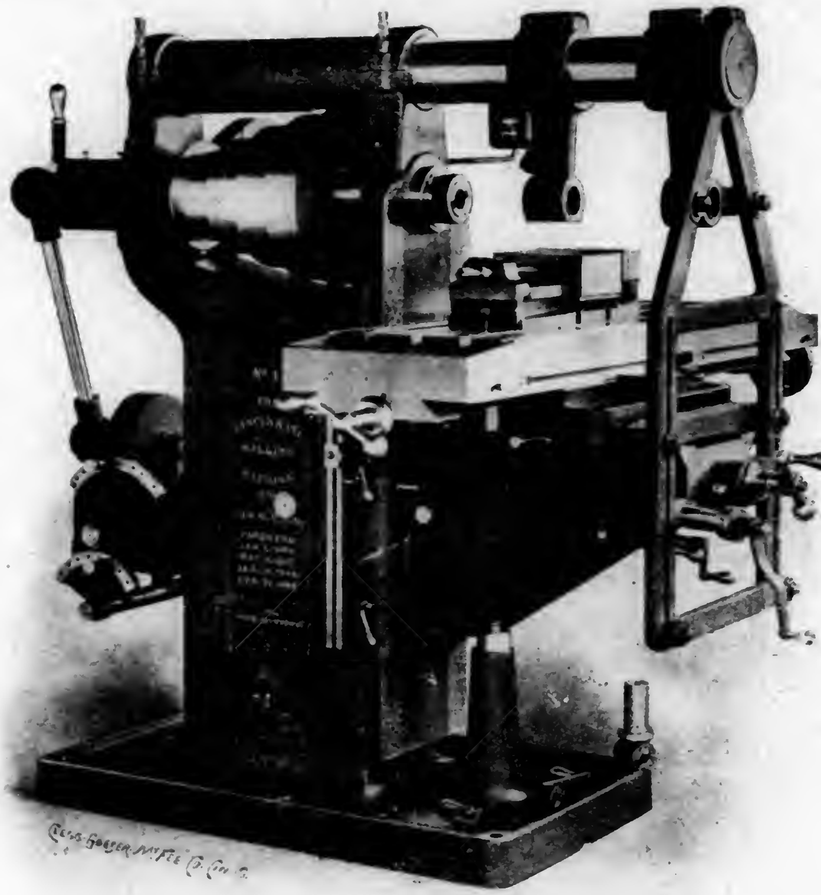


FIG. 12.—VIEW OF THE NO. 4 CINCINNATI MILLING MACHINE.

REMARKABLE LOCOMOTIVE PERFORMANCE.

MICHIGAN CENTRAL RAILROAD.

In recording the fast run of 118 miles in 127 minutes of a heavy passenger train on the Michigan Central in the January number, page 33, the grades were not given. From the elevations of the terminals there is a total rise of 242 ft. in 118 miles, an average grade of 2 ft. per mile against the train. The profile of the road received from Mr. Bronner shows the grade to be a nearly steady rise, with no difficult hills and no opportunities for spurts on down grades. The steepest grade is 21.1 ft. per mile for a distance of only ⅓ mile. Most of the grades are under 10 ft. per mile.

AT THE TICKET WINDOW.

"When does the next train that stops at McAllisterville leave here?"

"You'll have to wait four hours."

"I think not."

"Well, maybe you know better than I do, ma'am."

"Yes, sir, and maybe you know better than I do whether I am expecting to travel on that train myself, or whether I am inquiring for a relative that's visiting at my house and wanted me to call here and ask about it and save her the trouble because she's packing up her things and expects to take that train herself, and not me, and she will have to do the waiting, and not me, and maybe you think it's your business to stand behind there and try to instruct people about things they know as well as you do, if not better; but my idea is that you're put there because they couldn't use you in the switching department, and perhaps you'll learn some day to give people civil answers when they ask you civil questions; young man, my opinion is, you won't!"

(With a gasp) "Yes, ma'am!"—*Railroad Men.*

CORRESPONDENCE.

COMPARISONS OF LOCOMOTIVES.

To the Editor of the American Engineer:

As an accurate, convenient and simple basis for the comparison of the steaming capacity of both single-expansion and compound locomotives of all types, I beg to submit the following ratio:

$$\frac{\text{Square feet of total heating surface}}{\text{Maximum available tractive force}} \times 100;$$

or, the total heating surface in per cent. of the net tractive effort.

This expression contains all the factors necessary for a complete statement of the case, namely: the boiler pressure, the diameter and stroke of piston, the diameter of the driving wheels, and the heating surface; and it includes no terms which are taken or specially calculated for purposes of comparison. It requires no mathematical reasoning to demonstrate the obvious fact that for any given locomotive, whether simple or compound, the greater the heating surface in proportion to the maximum tractive force, the greater will be the steaming capacity of the engine, and vice versa; hence the above expression is a complete and accurate measure of the steaming power of all classes of locomotives, under all conditions of service.

Furthermore, by solving the foregoing expression for a number of recent and successful locomotives of different types, and tabulating the results, a mass of data can be readily obtained which will prove of value as a guide in future designing. For example, assume that experience has shown that for single-expansion, heavy, fast passenger locomotives, burning bituminous coal, a total heating surface equal to about 15.2 per cent. of the maximum available tractive force results in satisfactory steaming, and that it is desired to obtain this ratio in a new design of express locomotive whose maximum tractive power is, let us say, 23,222 lbs. Then the required heating surface is $0.152 \times 23{,}222 = 3{,}530$ sq. ft; which figures agree very closely with the dimensions of the 4—4—2 type express locomotive, whose remarkable performance on the Micngan Central Railroad was set forth on page 33 of the January (1903) issue of the American Engineer.

After careful thought it appears to me that the above expression is worthy of serious consideration as a standard method for the comparisons of the steaming capacity of both simple and compound locomotives, the selection of which standard of comparison has been much discussed of late in the technical press.

EDWARD L. COSTER,
A. M. Am. Soc. M. E.

25 Broad Street, New York, January 20, 1903.

THE SHOP AS A SCHOOL.

To the Editor:

Referring to your editorial on page 312 of the October number, in my opinion No. 1 is the man that will get on top. for with my experience I find that the man who covers the ground in three years that you have outlined is not fit for a master mechanic. He should be president of some of our transcontinental railway lines. I do not know of a single man, nor have I ever heard of one, doing it all in three years. I agree with Mr. R. D. Smith, superintendent of motive power of the Burlington & Missouri River Railroad, that it would take a wonderful young man to thoroughly fill all the places that he passed through in the three years.

In the first place, if he were a good boiler-washer, he would do his work so well that not more than one foreman in a hundred would give him anything better, because it would be hard to fill his place washing boilers. More good men are kept down in railroad shops because their places are too hard to fill than for anything else. I know a good lathe hand who would make a good foreman, but on a lathe he is turning out more work than two ordinary men, consequently he is kept there, while if he were placed in charge of the shop, in three years he might be master mechanic. This man may have push but no pull, yet he cannot go to the master mechanic and say, "I am the man you are looking for." Nine chances in ten, he would be discharged on the spot.

You often hear a great cry about men being afraid to speak up for fear of losing their positions; then, on the other hand. if he does speak up and say he does not care for his job, the man over him will say "indifference." Professor Randolph, from the Virginia Polytechnic Institute, hits the nail on the head when he says, "Every man has a chance to rise." In fact, he has to have it if he works in one of our modern railway shops. There is no room for a lazy man around a railway shop. Why? He would get run over.

Going back to the head of the question, "Which is the man?" I rather like No. 1, if he goes at it ~~right,~~ even if he is sent after a "bucket of blast," "half-round squares," "Johnson bars" and "red-lamp oil." He is in position to get what he came for, and if he does not get it, it is his own fault. Of course, he does not get the practical experience handling men, but if a man has it in him to rule or handle men, I think it does not take long to develop this faculty, and also that of knowing what to do at the proper time.

I have known more special apprentices to rise in the mechanical world than men starting as helpers and working up. If I wanted to become a locomotive engineer, I would start helping; but. on the other hand, if I wanted to become a master mechanic, I would start in as an apprentice and then finish out each detail until I had finished, then be open for engagement.

D. G. CUNNINGHAM,
A., T. & S. F. Ry. Roundhouse Foreman, Needles, Col.

To the Editor:

The question of "The Shop as a School" has been closely followed and with much interest. However, but one side has been presented, and I beg to bring to attention a few facts from the other point of view.

In beginning, let me enter a third contestant, C, in the race between A and B. He may or may not have had a technical or even university education, but he is the lucky son of capital or position, by virtue of which he is endowed with what is known simply as "a big pull." The question now of who wins is too easy, for it's a 100-to-1 shot with no takers that C will be a general manager while A and B are still wearing overalls. This case is not an exaggerated condition at all. but one which confronts A and B in the great majority of cases. How far do we have to look for an exhibition of partiality—what young man who is a "big" man in railroad work got there without "pull"?. These conditions are the chief disorganizers and reasons for demoralization—it's the reason B doesn't rise faster and it's what keeps A back a little.

Railroad men of the day should not lose sight of the plain truth that graduates enter railroad work at a great disadvantage as compared with other opportunities. It is a doubtful question whether railroad work offers sufficient inducements for the best fitted students to enter it. As for offering equal advantages, there can be no doubt. It is but necessary to compare for a moment the prospects of a young man void of "pull" in railroad work and in other fields. The former means long hours in one of the poorest places to live, very small pay to start with and for years to come, slow promotion and the hardest kind of work On the other hand, manufacturing and commercial concerns offer generally the advantages of a city, better salaries to start with and unquestionably larger and more frequent increases, shorter hours, and a wider range for the practice of the profession chosen. Is it any wonder that the young graduate turns to the brightest prospects and puts his energies where, even in the beginning, he can feel sure of getting some reward?

It is a fact that young men—graduates of technical schools—to-day consider railroads as affording the poorest field of any mechanical line. The writer, meeting a college friend not long ago (whose father before his death was a well-known motive-power man), was asked what he was doing. "Working for a railroad," was the reply, and instantly came the brotherly advice in the questioning form, "Why don't you quit it?" Another acquaintance who after college was also graduated from the apprentice course of one of the larger roads, was asked why he left railroad work, and forthwith the truthful answer came. "No money or promotion in it." A graduate of ten years' experience has lately been made electrical engineer of a 7,000-mile road at a salary that wouldn't pay his way through college. Another graduate of less than three years has been sent abroad by a manufacturing company at a nearly equal salary. These examples are *bona fide*, no "pull" being in any way present, and to offset them there is a general manager barely 30 years old, son of a president, and two division superintendents of about the same age who also have fathers. The writer at the time of his graduation was informed by those sup-

gear, F, meshes permanently with the smallest gear of nest, X, giving that nest a relatively high speed, and the smaller gear, U, meshes permanently with the smallest gear of nest Y giving that nest a relatively slow speed. In this way a wide range of speeds is available, in eight steps, by virtue of the two nests revolving at widely different speeds.

The manner of delivering motion from any one of the gears upon the two nests is very similar to that of the gear box first described in this series, differing mainly in the provision for bringing the receiving pinion, E, up against the cones. This intermediate gear, E, is feathered on the shaft, F, so as to slide along it, and is brought into mesh with any one of the eight cone gears by shifting the two levers, G and I, shown in Figs. 9, 11 and 12. The lower lever, I, moves the gear, E along its shaft, F, through the medium of a toothed sector, W, which meshes with the rack, Z, upon which is carried the guide block embracing the gear, E.

The proper position of the lever I, for a position of mesh by gear, E, is indicated by the eight holes upon the quadrant at the front into which the lever locks. After the gear, E, has been brought into position for mesh by means of lever, I, it is moved forward into mesh by the lever, G, which does so by moving the entire lower slide, R, of the box up toward the cones, the proper adjustment of this lever for bringing the pitch lines of the gears into coincidence being indicated by holes in its quadrant into which it locks. This movement of the slide, R, with respect to the lever, G, which is mounted on the frame of the mechanism, is accomplished by means of a helical groove, Gr, Fig. 11, on the lower side of its hub which engages with a pin on the upper side of the slide. Power is delivered from the shaft, F, through a feed shaft having universal joint connections to allow for the lateral movement of the slide, R.

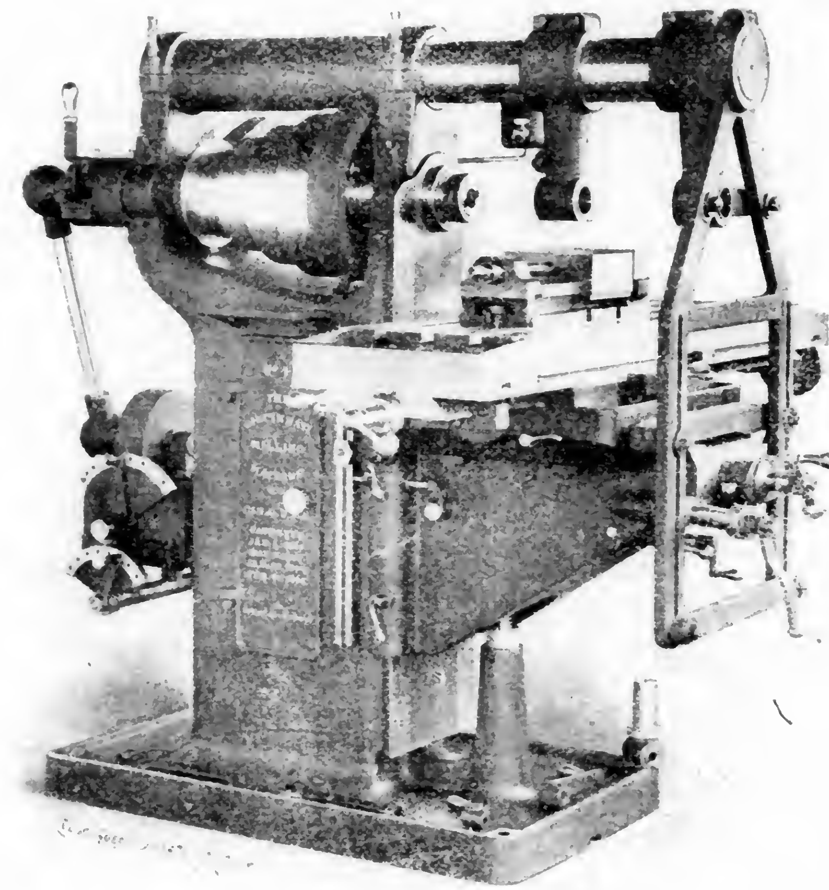


FIG. 12.—VIEW OF THE NO. 1 CINCINNATI MILLING MACHINE.

Fig. 12 is a general view of the No. 1 universal Cincinnati miller with this gear mechanism applied, the two-speed mechanism being above and the eight-speed mechanism below at the rear. It is so arranged that all levers may be operated from the front, but above all the extreme economy of space occupied by the complete mechanism for such a variation of 16 speeds possible, is to be noted; since the lower mechanism is capable of delivering eight different speeds, and the upper device may deliver two different speeds to it, the combined mechanism is capable of furnishing 16 different speeds. This device has the paramount advantage of having both of the gear mechanisms entirely closed and thus protected from dirt and injury. It is quite as simple in construction as the devices heretofore mentioned and involves no serious difficulties in its manipulation; while in the manner of design it gives evidence of the application of a great amount of ingenuity and is one of the best examples of applied mechanism to be found among the devices of this type.

REMARKABLE LOCOMOTIVE PERFORMANCE.

MICHIGAN CENTRAL RAILROAD.

In recording the fast run of 118 miles in 127 minutes of a heavy passenger train on the Michigan Central in the January number, page 33, the grades were not given. From the elevations of the terminals there is a total rise of 242 ft. in 118 miles, an average grade of 2 ft. per mile against the train. The profile of the road received from Mr. Brouner shows the grade to be a nearly steady rise, with no difficult hills and no opportunities for spurts on down grades. The steepest grade is 21.1 ft. per mile for a distance of only ½ mile. Most of the grades are under 10 ft. per mile.

AT THE TICKET WINDOW.

"When does the next train that stops at McAllisterville leave here?"

"You'll have to wait four hours."

"I think not."

"Well, maybe you know better than I do, ma'am."

"Yes, sir, and maybe you know better than I do whether I am expecting to travel on that train myself, or whether I am inquiring for a relative that's visiting at my house and wanted me to call here and ask about it and save her the trouble because she's packing up her things and expects to take that train herself, and not me, and she will have to do the waiting, and not me, and maybe you think it's your business to stand behind there and try to instruct people about things they know as well as you do, if not better; but my idea is that you're put there because they couldn't use you in the switching department, and perhaps you'll learn some day to give people civil answers when they ask you civil questions; young man, my opinion is, you won't!"

(With a gasp) "Yes, ma'am!"—*Railroad Men.*

CORRESPONDENCE.

COMPARISONS OF LOCOMOTIVES.

To the Editor of the AMERICAN ENGINEER:

As an accurate, convenient and simple basis for the comparison of the steaming capacity of both single-expansion and compound locomotives of all types, I beg to submit the following ratio:

$$\frac{\text{Square feet of total heating surface}}{\text{Maximum available tractive force}} \times 100;$$

the total heating surface in per cent. of the net tractive effort. This expression contains all the factors necessary for a complete statement of the case, namely: the boiler pressure, the diameter and stroke of piston, the diameter of the driving wheels, and the heating surface; and it includes no terms which are taken or specially calculated for purposes of comparison. It requires no mathematical reasoning to demonstrate the obvious fact that for any given locomotive, whether simple or compound, the greater the heating surface in proportion to the maximum tractive force, the greater will be the steaming capacity of the engine, and vice versa; hence the above expression is a complete and accurate measure of the steaming power of all classes of locomotives, under all conditions of service.

Furthermore, by solving the foregoing expression for a number of recent and successful locomotives of different types, and tabulating the results, a mass of data can be readily obtained which will prove of value as a guide in future designing. For example, assume that experience has shown that for single-expansion, heavy, fast passenger locomotives, burning bituminous coal, a total heating surface equal to about 15.2 per cent. of the maximum available tractive force results in satisfactory steaming, and that it is desired to obtain this ratio in a new design of express locomotive whose maximum tractive power is, let us say, 23,222 lbs. Then the required heating surface is $0.152 \times 23{,}222 = 3{,}530$ sq. ft; which figures agree very closely with the dimensions of the 4—4—2 type express locomotive, whose remarkable performance on the Michigan Central Railroad was set forth on page 33 of the January (1903) issue of the AMERICAN ENGINEER.

After careful thought it appears to me that the above expression is worthy of serious consideration as a standard method for the comparisons of the steaming capacity of both simple and compound locomotives, the selection of which standard of comparison has been much discussed of late in the technical press.

EDWARD L. COSTER.
A. M. Am. Soc. M. E.

25 Broad Street, New York, January 20, 1903.

THE SHOP AS A SCHOOL.

To the Editor:

Referring to your editorial on page 312 of the October number, in my opinion No. 1 is the man that will get on top, for with my experience I find that the man who covers the ground in three years that you have outlined is not fit for a master mechanic. He should be president of some of our transcontinental railway lines. I do not know of a single man, nor have I ever heard of one, doing it all in three years. I agree with Mr. R. D. Smith, superintendent of motive power of the Burlington & Missouri River Railroad, that it would take a wonderful young man to thoroughly fill all the places that he passed through in the three years.

In the first place, if he were a good boiler-washer, he would do his work so well that not more than one foreman in a hundred would give him anything better, because it would be hard to fill his place washing boilers. More good men are kept down in railroad shops because their places are too hard to fill than for anything else. I know a good lathe hand who would make a good foreman, but on a lathe he is turning out more work than two ordinary men, consequently he is kept there, while if he were placed in charge of the shop, in three years he might be master mechanic. This man may have push but no pull, yet he cannot go to the master mechanic and say, "I am the man you are looking for." Nine chances in ten, he would be discharged on the spot.

You often hear a great cry about men being afraid to speak up for fear of losing their positions; then, on the other hand, if he does speak up and say he does not care for his job, the man over him will say "indifference." Professor Randolph, from the Virginia Polytechnic Institute, hits the nail on the head when he says, "Every man has a chance to rise." In fact, he has to have it if he works in one of our modern railway shops. There is no room for a lazy man around a railway shop. Why? He would get run over.

Going back to the head of the question, "Which is the man?" I rather like No. 1, if he goes at it right, even if he is sent after a "bucket of blast," "half-round squares," "Johnson bars" and "red-lamp oil." He is in position to get what he came for, and if he does not get it, it is his own fault. Of course, he does not get the practical experience handling men, but if a man has it in him to rule or handle men, I think it does not take long to develop this faculty, and also that of knowing what to do at the proper time.

I have known more special apprentices to rise in the mechanical world than men starting as helpers and working up. If I wanted to become a locomotive engineer, I would start helping; but, on the other hand, if I wanted to become a master mechanic, I would start in as an apprentice and then finish out each detail until I had finished, then be open for engagement.

D. G. CUNNINGHAM.
A., T. & S. F. Ry. Roundhouse Foreman, Needles, Cal.

To the Editor:

The question of "The Shop as a School" has been closely followed and with much interest. However, but one side has been presented, and I beg to bring to attention a few facts from the other point of view.

In beginning, let me enter a third contestant, C, in the race between A and B. He may or may not have had a technical or even university education, but he is the lucky son of capital or position, by virtue of which he is endowed with what is known simply as "a big pull." The question now of who wins is too easy, for it's a 100-to-1 shot with no takers that C will be a general manager while A and B are still wearing overalls. This case is not an exaggerated condition at all, but one which confronts A and B in the great majority of cases. How far do we have to look for an exhibition of partiality—what young man who is a "big" man in railroad work got there without "pull"? These conditions are the chief disorganizers and reasons for demoralization; it's the reason B doesn't rise faster and it's what keeps A back a little.

Railroad men of the day should not lose sight of the plain truth that graduates enter railroad work at a great disadvantage as compared with other opportunities. It is a doubtful question whether railroad work offers sufficient inducements for the best fitted students to enter it. As for offering equal advantages, there can be no doubt. It is but necessary to compare for a moment the prospects of a young man void of "pull" in railroad work and in other fields. The former means long hours in one of the poorest places to live, very small pay to start with and for years to come, slow promotion and the hardest kind of work. On the other hand, manufacturing and commercial concerns offer generally the advantages of a city, better salaries to start with and unquestionably larger and more frequent increases, shorter hours, and a wider range for the practice of the profession chosen. Is it any wonder that the young graduate turns to the brightest prospects and puts his energies where, even in the beginning, he can feel sure of getting some reward?

It is a fact that young men—graduates of technical schools—to-day, consider railroads as affording the poorest field of any mechanical line. The writer, meeting a college friend not long ago (whose father before his death was a well-known motive-power man), was asked what he was doing. "Working for a railroad," was the reply, and instantly came the brotherly advice in the questioning form, "Why don't you quit it?" Another acquaintance who after college was also graduated from the apprentice course of one of the larger roads, was asked why he left railroad work, and forthwith the truthful answer came, "No money or promotion in it." A graduate of ten years' experience has lately been made electrical engineer of a 7,000-mile road at a salary that wouldn't pay his way through college. Another graduate of less than three years has been sent abroad by a manufacturing company at a nearly equal salary. These examples are *bona fide*, no "pull" being in any way present, and to offset them there is a general manager barely 30 years old, son of a president, and two division superintendents of about the same age who also have fathers. The writer at the time of his graduation was informed by those sup

posed to be in charge that it would take two years to reach his name on the waiting list of applicants for admission to the apprentice course of a certain railroad's shops. In just about that time a newspaper, under the caption "Sons of Millionaires Build Engines," made a target of several who graduated one and two years after I did. The son of the superintendent of a locomotive works who refused me a job in the shops is now ready to enter the field, and will be watched with some interest in his efforts.

In conclusion, and speaking for those to come, as well as for the present employees, the writer suggests a pointer which if better regulated would certainly increase the efforts and temptations of those in railroad work:

1. A fair field, with no favorites for the positions we are all aiming for.

2. Salaries equal to those which can be obtained from other concerns, offering, besides shorter hours, less night work and an opportunity to see something of life other than the passing of the "limited express" twice a day.

3. Assurance that there is always room at the top, which it should be understood is a height not a million miles off and which is unencumbered by a lot of healthy men at present.

G. W. C.

To the Editor:

In fairness to both men under consideration, and to best realize what each accomplishes in three years, I will consider them to a slight extent in detail, and quote portions from the original where desirable.

Judging from what the second man accomplished in the roundhouse, he must have remained there about one year. At the beginning of the second year, I will assume, he enters the shop. In that year he eats at the table with the men, lives among them, understands them thoroughly, gains the friendship and respect of men and bosses, becomes the best man in the gang, and is selected for gang foreman and fills the position successfully—in one year.

With no actual previous training, he enters the machine shop, is started on eccentric straps, and in spite of the jealousy of the men and discourageemnt from the foreman, in less than a year, probably nine months, he is not only appointed assistant foreman, but is holding the position successfully. In the other three months of the year he is firing a locomotive and holding his own with the rest. A record of progress in one year even excelling that of his second year. Sub-foreman, we might say, of roundhouse, gang foreman of erecting shop, assistant foreman of machine shop, and locomotive fireman—in three years. It is small wonder he is popularly considered the best man—"Because he is painted so."

And what of the other fellow of *assumed* equal ability who has spent three years in the shop? Has he not gained the respect and friendship of the men and bosses? If he has not—and the article infers this—he is not of equal ability with the second. Has he in three years gained nothing but "a general insight into shop practices"? Then he is not of equal ability with the second. Is the best that can be said, "He does very well"? The article also says, "He ought to be prepared for a position of responsibility, if he has profited by his opportunities," qualifying a praise by suggesting the contrary. Farther, the article says, "The shop is modified to suit the first, and the officers of the road do him homage." This is cited as a strong point against him, and yet in reading the article it seems that the shop is more modified to suit the second man, and I think it reacts more to his credit than otherwise; and yet the original suggests the moral, "It is a disadvantage to cultivate the good will of one's superiors."

The popular view that No. 2 is the better man is not surprising. He *is* the better man, "Because he is painted so." The hypothesis that the men are of equal ability equal mental and physical skill, seems in the article to have been entirely lost sight of. No. 2 is an exceptional man and will succeed, as he has thus far succeeded, in whatever he undertakes. No. 1 has been unattractively painted, and has evidently accomplished little of value to himself or to the company.

In conclusion, I claim that the original supposition has by no means been carried out, for with equal ability and mental skill or tact they will both find their level as surely as water unrestrained will find its level, and they will rise side by side until the character and personal attributes of one gain for him some especial and well-merited reward.

F. E. SEELEY.

To the Editor:

As it has not been so very long since I was a special apprentice myself, I have read with interest your editorial in the October number and the replies thereto in the November number, comparing the work and value of a special apprentice with those of another technical young man who goes alone into the shop and, according to the story, wins on his merits.

It seems to me that man No. 1 is practically ignored and the whole article focused on man No. 2, who is certainly a prodigy for accomplishing all the things he is credited with in the time allowed him—three years. Suppose you take the smartest young man graduated from the best technical school in the country and let him enter the boiler-washing gang in some roundhouse, being entirely unknown to the officials of the mechanical department. Do you believe that in a few months he will have improved the methods of boiler washing to such an extent that his ability will be noticed and make him foreman of the gang? Again, he goes into the erecting shop and in less than a year has overcome prejudice of foreman and men, learned all that is necessary to know in order to become a gang boss—a five to ten years' job for an ordinary man—and has become a gang boss, being placed over good, capable men of ten to twenty years' experience! Does this seem probable? Again, he goes into the machine shop as a lathe hand and is soon offered the position of assistant foreman, having presumably worked his way around to all the various machines and mastered them all, else he would not be competent to direct the work of others. After this last achievement he goes to firing, and is soon a regular member of the freight pool—all of this inside of three years.

It seems to me that anyone thinking this matter over thoughtfully cannot help but come to the conclusion that it would be impossible for any man to accomplish in three years what man No. 2 was credited with doing.

In regard to the statement that special apprentices are given special privileges and led to believe that they are being trained for official positions and are "The Coming It," as Mr. Whyte expressed it, I would like to say a word, viz., that in the shop in which I worked the special apprentice had no special privileges, the regular apprentice being moved around from one kind of work to another with the same regularity as was the special apprentice, and worked in the same departments. The only "special privilege" the special apprentice had over his less fortunate brother was the privilege of saving money for "the company" by running hard road tests at the rate of $35 per month, when otherwise they would have had a $100 or $125 engineer of tests.

In regard to the idea that the special apprentice is given to believing himself the coming railroad official, I would say that where I "served my time" we were given to understand that our semi-contract with the railroad company ended in three years. At that time, if we had proved of value to the company, we would be retained, and promoted as opportunity and our abilities permitted. It seems to me that a man who has spent four years in a technical school, is from 23 to 24 years of age, and is willing to spend three years in a railroad shop, starting in at 12½ cents per hour, all for the sake of the experience he will obtain, should be credited with more sense than to believe that all he had to do to become an official was to pass three years in a railroad shop.

W. S. R.

AN IMPROVED KNUCKLE PIN FOR PASSENGER COUPLERS.

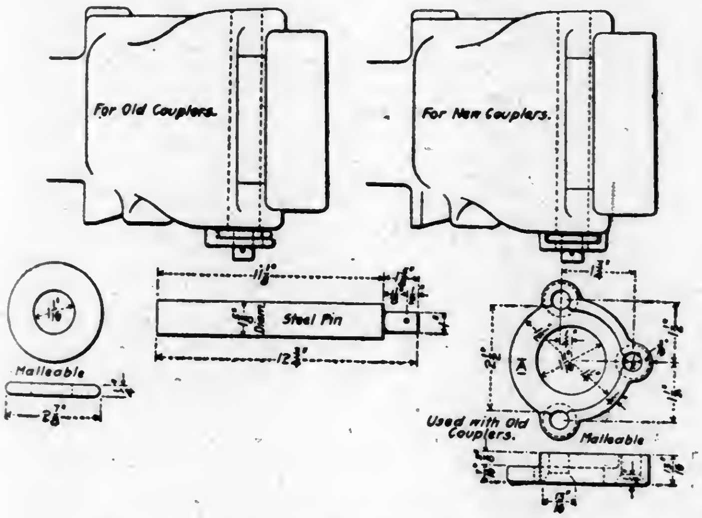
MICHIGAN CENTRAL RAILROAD.

The difficulty met with in removing and replacing knuckles and knuckle-pins of passenger couplers is a serious one on account of the buffers overlapping the pins to such an extent that the pins cannot be removed without first in some way compressing the buffers, removing them, or by taking down the couplers.

A knuckle-pin for passenger couplers, so constructed that it could be as easily and quickly removed as with freight couplers, has been, up to the present time, an unsolved problem. One, however, meeting all requirements, that will commend itself to railroad men generally, and to car men in particular, simple in construction and operation, inexpensive, and that

does not change existing conditions, has been devised on the Michigan Central Railroad and is already in use on many cars. This simple device is so clearly illustrated in the accompanying engraving that little remains to be said in the way of explanation.

The pin is made without a head in order to permit its movement downward through the coupler-head. Its lower end is reduced in size below that of the body, thus forming what may for convenience's sake be called a pintle. A detachable support, or washer, with a hole through its center just sufficiently large to receive the pintle end, furnishes a support for the pin; this, in turn, is carried by another and fixed support, cast on or fastened to the under side of the lower lug, cored out in such a manner as to provide a seat for the detachable support, hold it in position, and permit of its being inserted or removed at will. Through this fixed support is a hole of the full size of the pin, through which the pin may pass freely to and from the coupler when the detachable support, or washer, is removed. As will be readily seen, when in place the pin rests on, and its weight is carried by, the detachable support, which, in turn, is held in place by the fixed one. To remove the pin, it is raised until the pintle end is clear of the movable support.



KNUCKLE PIN SUPPORT FOR PASSENGER COUPLERS.

This support is then taken from its seat out through the slot in the side of the fixed support, which leaves the passage clear for the downward removal of the pin. In replacing, the reverse of this operation is, of course, followed.

For couplers already in use, provision is made for the headless pin by making the fixed support as a separate piece and fastening it to the coupler by means of machine bolts. This method has proven very satisfactory. The engraving shows the device as applied to old and also to new couplers.

In freight couplers there is no advantage in headless pins, nor in removing them from the under side; but there is a great advantage, in both passenger and freight, in having the pins supported at the lower end instead of at the upper, which will hold in place the lower end or piece of pins that often break in service, invariably resulting in breaking off the upper lug of the coupler. The loss from this cause is extremely large, as was shown by a paper read before the Western Railway Club at its meeting in Chicago last May; so it can be said that the bottom-supported pin is valuable for both passenger and freight couplers.

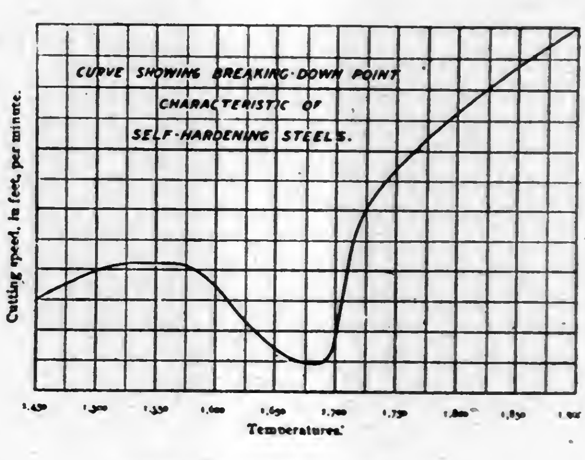
This device is receiving a great deal of attention from railroad men, who invariably speak in favorable terms of its merits. It is the invention of Mr. J. A. Chubb, superintendent of air-brakes of the Michigan Central Railroad.

THE REQUIREMENTS OF MACHINE TOOL OPERATION.

WITH SPECIAL REFERENCE TO THE MOTOR DRIVE.

The tool steel is the keynote to the situation and a complete knowledge of its characteristics and possibilities form the starting point for all further work. Carbon steel will give a finer finish on steel than the air hardening variety and, for form cutters, is still largely used. Where heavy roughing cuts are possible, air hardening steel has unquestionably replaced it and, in fact, the recent developments in the processes of hardening have been the direct means of revolutionizing old methods of machine tool design and so-called shop practice.

We must ever bear in mind that "best shop practice" should mean "arriving at the desired result at the least cost" and can be used in a relative sense only. We constantly hear machinists condemn a means of arriving at a result irrespective of its merits, their reason being that "it is not good practice." If drilling with a feed of 1-16 of an inch per revolution gives the desired finish in much less time, it is certainly good practice and if, under these conditions, we find a sharp point on the drill is not essential, so much the better. Twist drills are



BREAKING-DOWN POINT OF STEELS.

now run from four to six times as fast as used to be considered possible.

The influence of the Taylor-White process tool steel has been so revolutionary in character that it merits dwelling upon it. The underlying principle of this discovery is clearly shown on the accompanying curve, which is plotted from values of cutting speeds and temperatures. It will be seen that this curve rises from the zero point until the temperature of 1550 degrees is reached, when the cutting values suddenly fall off, this representing the full extent of our knowledge, when the experiments at Bethlehem were undertaken. The most interesting and valuable fact, that these values again increase if the hardening temperature is carried beyond the "breaking down points," was the result of the work just referred to, and the superiority of steel treated in this way as compared with Sheffield Mushett—which was probably equal to any air-hardening steel on the market at that time, may be expressed as follows:

	Mushett.	Taylor-White.
10 C Steel	1.0	2.2
30 C Steel	1.0	3.5
Cast Iron	1.0	1.3

These figures are the result of a series of tests conducted by the Franklin Institute and represent the facts as nearly as they could be determined. There are now a number of makes of steel in the market treated along the lines explained above, which give equally as good results.

An exact knowledge of the cutting speeds of which these tools will permit when machining different materials, and the

power to pull various cuts under all conditions, are absolutely essential if we wish to properly design machine tools or use them to their full capabilities in actual service. The value of this information is now being realized by several of the machine tool builders and the results are already being felt in the shop in the form of much more efficient tools.

The motor drive makes the measurement of power so simple that we may arrive at these results with comparatively little difficulty. A series of experiments was recently conducted in the shops of the Link-Belt Engineering Co. to determine the best air hardening tool steel for use on cast iron, using a specially arranged testing lathe and the necessary accessories. This particular lathe gives 126 spindle speeds increasing in 5 per cent. increments and is especially adapted to this work. It is a 48-in. Louge & Shipley lathe with its motor controller operated from the carriage; it has 42 speeds ahead and six reserve, in a range of 6 to 1. Electrical instruments were used to take records of the energy absorbed and the cutting speeds were carefully determined by suitable instruments.

The accompanying table is a portion of a record and shows the method of tabulating this data. One hundred and twenty-five tests on various tools were made in this series of experiments, the depth of cut and feed being kept constant and the speed varied so that the tool would last just twenty minutes.

TESTS OF TOOL STEELS.

Cast Iron. Cutting, Dry. November 24, 1902. Tool—1¾ in.x⅞ ins. Kind of Steel in Tool, Self-Hardening. Kind of Tool, Right Hand Roughing. Clearance Angle of Tool, 8 Degrees. Rake Angle of Tool { Front 2 Deg's. Side 20 Deg s.

Experiment Number	Feed.	Depth of Cut.	Cutting Speed in Feet per minute.	Mark on Tool.	Duration of Cut in minute.	Diam. at Top of Cut in inches.	Diam. at Bottom of Cut in inches.	Tool started from Top end in inches.	Volts.	Amperes.	Total Longitudinal Feed of Tool in inches.	Remarks
24	.0606	3/16	{ 97. 91.7	Taylor White H. S. H. No. 1.	16¼	21⅜	21	0	{ 130 131	30 5	16⅛	RUINED.
25	.0606	3/16	{ 103. 100.	Capitol No. 1.	20	21⅜	21	16⅛	{ 170 172	24 5	21¾	FAIR.
26	.0606	3/16	{ 105. 104.	Capitol No. 2,	20	21⅜	21	37⅞	{ 71 172	4 5	$22\frac{11}{16}$	GOOD.
27	.0606	3/16	{ 194. 101.	Capitol No. 3.	13	21	20⅝	0	{ 167 170	27 5	14½	RUINED.
28	.0606	3/16	{ 104. 101	Taylor White No 1. T. W.	11¼	21	20⅝	14½	{ 164 172	26 5	12½	RUINED.
29	0606	3/16	{ 100. 99.1	Jessop No. 1.	20	21	20⅝	27	{ 132 135	26. 5	20⅞	GOOD.
30	.0606	3/16	{ 105. 101.	Jessop No. 2.	20	20⅝	20¼	0	{ 166 167	24 5	$22\frac{11}{16}$	RUINED.
31	.0606	3/16	{ 107. 197.5	Jessop No. 1.	20	20⅝	20¼	$22\frac{11}{16}$	{ 168 170	24 5	23	GOOD.
32	0606	3/16	{ 115.5 111.5	Jessop No. 4.	13	20⅝	20¼	$45\frac{11}{16}$	{ 168 170	25 5	16¼	GOOD.
33	.0606	3/16	{ 125. 115.	Jessop No. 3.	$2\frac{1}{12}$	20¼	19⅞	0	{ 166 170	28 5	2¾	RUINED.
34	.0606	3/16	{ 118. 109.	Jessop No. 2.	10¾	20¼	19⅞	2¾	{ 167 170	28 5	$13\frac{3}{16}$	RUINED.
35	.0606	3/16										

A few experiments only would prove of little value, as the factors are so variable in character. The uniformity of the tool must be determined, then the cutting speed for material of all kinds, and finally the relations between these quantities should be ascertained and empirical formulæ derived.

With the present light on the subject, it seems strange indeed how machine tools could have been designed in the past, and it is not strange that we can now criticise the course pursued. We do feel, however, that the manufacturers of such apparatus are slow in adopting the proper course, although in every instance we have found them open to conviction and glad to discuss the problem from the present standpoint.

It is not now my intention to discuss the subject of machine tool design, but I do wish to say that the most inefficient part of most shops is the machine tool equipment, and until the user of this apparatus realizes this point and demands machines designed along the correct lines the desired result will not be reached.

To those who have not given the subject close study this statement may seem to be without foundation, but it matters not what type of tool we consider, its shortcomings can be readily pointed out. The feeds on the average drill press are ridiculously low, the power supplied and rigidity of the frame on machines using multiple cutters are out of all proportion to the work we should be able to absorb at the cut, and so on.

The foregoing paragraphs were selected, as of unusual interest to the users of machine tools, from an admirable paper delivered recently before the New York Electrical Society by Mr. Charles Day, of the firm of Dodge & Day, Philadelphia, Pa. His paper is an excellent treatment of this important subject and we heartily recommend our readers to secure complete copies of the paper for further study, which may be obtained from the secretary of the society, Mr. Geo. H. Guy, 114 Liberty street, New York City.

Mr. T. S. Lloyd, superintendent of motive power of the Delaware, Lackawanna & Western, has been given charge of the car department upon the retirement of Mr. L. T. Canfield from railroad service. Thus another independent car department is placed under the direction of motive-power officers. Mr. Lloyd has in two years put the locomotive department of this road into excellent condition, and the able management of Mr. Canfield has brought the car department to a plane which will render it easy to conduct the two in one office. The high esteem in which Mr. Canfield is held by his former associates was manifested by a large gathering of his friends on the occasion of his leaving his office and the unexpected presentation of beautiful and appropriate tokens. His ability and efficiency as an officer are accompanied by unusual personal traits which make his subordinates and associates his friends; in fact his relations with his subordinates constitute no small part of the reason for his success. Mr. Canfield is now vice-president of the Standard Railway Equipment Company, of St. Louis. Mr. Lloyd has reorganized the car-department official staff to suit the new conditions and has extended the jurisdiction of the various mechanical officers over the car department. Mr. Lloyd was educated at the Western University, near Pittsburgh, and was an apprentice at the Pittsburgh Locomotive Works. After serving as machinist in a number of railroad shops he was made foreman at Fort Wayne, under Mr. F. D. Casanave. In 1890 he went to the Chesapeake & Ohio, as master mechanic of the Cincinnati division, and was promoted to the position of general mechanic at Richmond. The present addition to his responsibilities is one for which he is admirably prepared.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

XIII.

Report by Prof. W. F. M. Goss.

SECTION V.

(Continued from Page 362, December, 1902.)

Editor's Note.—This portion of the report includes Tables VI. to XIII., inclusive. Next month we shall proceed with the text.

TABLE VI.

TWENTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	20
	R. P. M.	97.2
Pounds of Steam Used	Per Hour	8090
	Per Minute	135
Cut Off	In Inches	5.8
	In Per Cent. of Stroke	23.8

M. E. P. 63 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed. Back Pressure, lbs.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
Base No. 1	1	1.2	.8	.028	.024
	2	1.23	.9	.0324	.026
	3				
	4	1.2	1.	.036	.05
	5	1.1	.8	.028	.026
	6	1.3	.8	.0288	.022
	7	1.5	1.	.036	.024
1-A	1	1.20	1.0	.036	.030
	2	1.25	1.2	.043	.034
	3	1.25	1.	.036	.029
	4	1.25	1.2	.043	.04
	5	1.12	1.3	.0468	.042
	6	1.3	1.3	.0468	.036
	7	1.4	1.	.036	.026
1-B	1	1.4	1.0	.036	.026
	2	1.25	1.1	.0396	.032
	3	1.32	1.	.036	.027
	4	1.	1.1	.0396	.04
	5	1.1	1.2	.0432	.039
	6	1.3	1.3	.0468	.036
	7	1.35	1.3	.0468	.035
1-C	1	1.25	1.0	.036	.029
	2	1.25	1.1	.0396	.032
	3	1.25	.9	.0324	.026
	4	1.2	1.2	.043	.036
	5	1.11	1.2	.0432	.034
	6	1.2	1.3	.0468	.039
	7	1.45	1.4	.0503	.035
1-D	1	1.2	.9	.032	.027
	2	1.24	.9	.0324	.026
	3	1.28	1.25	.045	.035
	4	1.1	1.2	.0432	.039
	5	1.09	1.3	.0468	.043
	6	1.3	1.5	.054	.042
	7	1.25	1.5	.054	.043
2-A	1	1.1	1.7	.028	.055
	2	1.25	1.6	.0576	.046
	3	1.26	1.6	.0576	.046
	4	1.2	1.8	.0648	.054
	5	1.15	1.6	.0576	.050
	6	1.3	1.4	.050	.038
	7	1.35	1.3	.0468	.035
2-B	1	1.1	2.3	.083	.075
	2	1.25	2.2	.0792	.063
	3	1.23	2.	.072	.059
	4	1.2	2.3	.0828	.069
	5	1.2	2.3	.0828	.069
	6	1.3	2.	.072	.055
	7	1.25	1.7	.0612	.048
2-C	1	1.05	2.4	.086	.083
	2	1.15	2.4	.0864	.075
	3	1.24	2.7	.0972	.078
	4	1.2	2.6	.0936	.078
	5	1.11	2.4	.0864	.078
	6	1.3	2.4	.0864	.066
	7	1.3	2.1	.076	.058
2D	1	1.1	2.7	.097	.088
	2	1.1	2.7	.097	.088
	3	1.25	2.8	.1008	.081
	4	1.2	3.	.108	.090
	5	1.10	2.9	.1044	.095
	6	1.2	2.6	.0936	.078
	7	1.2	2.2	.0792	.065
Base No. 2	1				
	2	1.2	1.4	.0504	.042
	3				
	4	1.2	1.3	.047	.039
	5	1.06	1.1	.04	.037
	6	1.4	1.	.036.	.026
	7	1.2	.6	.022	.018
3-A	1	1.1	1.4	.05	.046
	2	1.2	1.8	.0648	.05
	3	1.2	1.95	.070	.058
	4	1.2	1.8	.065	.054
	5	1.09	1.6	.058	.053
	6	1.3	1.7	.061	.047
	7	1.25	1.2	.043	.035
3-B	1	1.2	1.6	.057	.047
	2	1.23	2.	.072	.058
	3	1.25	2.	.072	.057
	4	1.2	1.9	.068	.057
	5	1.1	2.	.072	.065
	6	1.3	2.	.072	.055
	7	1.4	2.	.072	.051
3-C	1	1.1	1.6	.057	.052
	2	1.22	1.9	.0684	.056
	3	1.19	2.	.072	.060
	4	1.2	2.	.072	.06
	5	1.1	2.3	.083	.075
	6	1.2	2.1	.076	.063
	7	1.25	2.4	.086	.069
3-D	1	1.45	1.3	.046	.038
	2	1.22	1.9	.0684	.056
	3	1.2	2.	.072	.06
	4	1.2	2.	.072	.06
	5	1.05	2.4	.086	.083
	6	1.2	2.3	.083	.069
	7	1.2	2.5	.090	.075
4-A	1	1.3	1.9	.068	.053
	2	1.17	2.5	.09	.077
	3	1.22	2.1	.076	.062
	4	1.2	2.0	.072	.060
	5	1.16	1.8	.065	.056
	6	1.20	1.6	.058	.048
	7	1.40	1.1	.040	.028
4-B	1	1.3	2.3	.083	.063
	2	1.13	2.7	.0972	.086
	3	1.20	2.4	.086	.072
	4	1.25	2.4	.085	.069
	5	1.19	2.5	.090	.076
	6	1.2	2.0	.072	.060
	7	1.25	1.5	.054	.043
4-C	1	1.3	2.6	.094	.072
	2	1.15	2.9	.1042	.091
	3	1.15	2.9	.104	.091
	4	1.2	2.8	.100	.084
	5	1.2	2.7	.097	.081
	6	1.3	2.4	.086	.066
	7	1.35	2.2	.079	.059
4-D	1	1.2	2.9	.104	.087
	2	1.17	3.3	.1188	.102
	3	1.19	3.0	.108	.090
	4	1.2	3.0	.108	.09
	5	1.3	3.1	.112	.086
	6	1.2	3.0	.108	.090
	7	1.2	2.3	.083	.069
Base No. 3	1				
	2	1.2	1.9	.0684	.057
	3				
	4	1.1	1.5	.054	.048
	5				
	6	1.35	.8	.0288	.021
	7	1.35	.50	.018	.013
5A	1	1.12	2.0	.072	.064
	2	1.27	2.4	.0864	.068
	3	1.23	2.0	.072	.058
	4	1.2	1.9	.0684	.057
	5	1.14	1.9	.0684	.06
	6	1.25	1.4	.0504	.04
	7	1.45	1.2	.0432	.03
5-B	1	1.13	2.	.072	.064
	2	1.3	2.7	.0972	.075
	3	1.24	2.2	.0792	.064
	4	1.2	2.4	.0864	.072
	5	1.14	2.2	.0792	.07
	6	1.35	2.1	.0756	.058
	7	1.35	1.9	.0684	.051
5-C	1	1.12	2.1	.075	.067
	2	1.21	2.4	.0864	.072
	3	1.25	2.4	.0865	.069
	4	1.15	2.5	.090	.078
	5	1.11	2.6	.0936	.084
	6	1.25	2.4	.0864	.069
	7	1.3	2.1	.0756	.058
5-D	1	1.12	2.2	.079	.071
	2	1.18	2.4	.0864	.073
	3	1.21	2.7	.0972	.080
	4	1.2	2.7	.0972	.081
	5	1.10	3.0	.108	.098
	6	1.3	2.7	.0972	.075
	7	1.35	2.8	.1008	.075
6-A	1	1.12	2.2	.079	.07
	2	1.21	2.4	.0864	.071
	3	1.1	2.2	.0792	.072
	4	1.3	2.	.072	.055
	5	1.11	1.6	.0576	.052
	6	1.25	1.4	.0504	.04
	7	1.35	1.	.036	.027
6-B	1	1.2	2.6	.093	.078
	2	1.2	2.8	.1008	.084
	3	1.2	2.7	.0972	.081
	4	1.2	2.3	.0828	.069
	5	1.13	2.1	.0756	.067
	6	1.3	1.8	.0649	.05
	7	1.25	1.4	.0504	.04
6-C	1	1.2	3.	.108	.09
	2	1.17	3.	.108	.092
	3	1.2	3.	.108	.09
	4	1.2	2.6	.0936	.078
	5	1.11	2.6	.0936	.084
	6	1.3	2.1	.0756	.058
	7	1.15	1.7	.0612	.053
6-D	1	1.2	3.3	.119	.099
	2	1.14	3.1	.1116	.097
	3	1.2	3.1	.1116	.092
	4	1.4	3.1	.1116	.08
	5	1.11	2.7	.0972	.088
	6	1.2	2.3	.0828	.069
	7	1.3	2.2	.0792	.061
Base No. 4	1				
	2	1.23	1.9	.068	.055
	3				
	4	1.25	1.2	.043	.035
	5				
	6	1.35	.6	.021	.016
	7	1.30	.4	.014	.012
7-A	1	1.14	2.1	.076	.066
	2	1.23	2.3	.082	.067
	3	1.17	2.	.072	.061
	4	1.2	1.8	.064	.054
	5	1.18	1.4	.05	.043
	6	1.2	1.1	.039	.032
	7	1.35	.9	.032	.024
7-B	1	1.14	2.3	.083	.072
	2	1.2	2.7	.097	.081
	3	1.17	2.4	.086	.073
	4	1.25	2.3	.082	.066
	5	1.12	2.2	.079	.071
	6	1.25	1.7	.061	.049
	7	1.15	1.5	.054	.047
7-C	1	1.17	2.6	.094	.08
	2	1.25	2.9	.104	.083
	3	1.23	2.6	.093	.076
	4	1.2	2.5	.09	.075
	5	1.11	2.5	.09	.081
	6	1.3	2.3	.082	.064
	7	1.2	1.9	.068	.056
7-D	1	1.09	2.4	.086	.079
	2	1.3	3.4	.122	.094
	3	1.3	3.2	.115	.088
	4	1.25	2.8	.1	.081
	5	1.11	2.9	.104	.094
	6	1.25	2.6	.093	.075
	7	1.2	2.4	.086	.07
8-A	1	1.1	2.4	.086	.07
	2	1.2	2.4	.086	.072
	3	1.25	2.2	.079	.063
	4	1.25	1.7	.061	.049
	5	1.13	1.4	.050	.045
	6	1.4	1.	.036	.026
	7	1.2	.6	.021	.017
8-B	1	1.2	2.8	.1	.083
	2	1.23	2.6	.093	.076
	3	1.2	2.4	.086	.08
	4	1.25	2.	.072	.058
	5	1.12	2.	.072	.064
	6	1.3	1.4	.050	.039
	7	1.25	1.	.036	.029
8-C	1	1.13	2.8	.1	.089
	2	1.15	2.9	.104	.091
	3	1.18	2.6	.093	.077
	4	1.2	2.3	.082	.069
	5	1.1	2.	.072	.065
	6	1.3	1.7	.061	.047
	7	1.3	1.4	.05	.039
8-D	1	1.15	2.9	.104	.09
	2	1.18	3.1	.111	.094
	3	1.1	3.0	.108	.098
	4	1.2	2.6	.093	.078
	5	1.2	2.4	.086	.072
	6	1.2	2.	.072	.06
	7	1.3	1.6	.057	.043
Normal, Petticoat Pipe In	*	1.2	2.9		
Normal, Petticoat Pipe Out	*	1.4	2.6	.093	.066
Sliding A	1	1.4	2.4	.086	.061
	2	1.3	2.1	.075	.057
	3	1.3	2.0	.072	.055
Sliding B	1	1.5	2.2	.079	.054
	2	1.2	2.4	.086	.071
	3	1.4	2.5	.09	.064
Sliding C	1	1.2	2.6	.093	.077
	2	1.2	2.8	.101	.084
	3	1.2	2.6	.093	.077
Sliding D	1	1.2	2.8	.1008	.084
	2	1.2	2.6	.093	.077
	3	1.2	3.	.108	.09

* Normal.

TABLE VII.

THIRTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	30
	R. P. M.	145.8
Pounds of Steam Used	Per Hour	10548
	Per Minute	175
Cut-Off	In Inches	6.
	In Per Cent. of Stroke	25.3

M. E. P. 55.6 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed. Back Pressure, lbs.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
	1	1.85	.75	.027	.015
	2	1.65	.9	.036	.022
	3				
Base No. 1	4	1.8	1.1	.0396	.022
	5	1.63	1.8	.036	.022
	6	1.8	1.8	.036	.02
	7	1.8	1.1	.0396	.022
	1	1.75	1.25	.036	.021
	2	1.75	1.25	.045	.026
	3	1.79	1.3	.0468	.026
1-A	4	1.8	1.4	.0504	.028
	5	1.64	1.4	.0504	.037
	6	1.8	1.4	.0503	.028
	7	1.9	1.2	.0433	.023
	1	1.6	.9	.032	.02
	2	1.7	1.2	.0432	.025
	3	1.84	1.2	.0432	.023
1-B	4	1.5	1.5	.0546	.036
	5	1.63	1.6	.0576	.035
	6	1.8	1.6	.0576	.032
	7	1.8	1.6	.0576	.032
	1	1.9	1.	.036	.019
	2	1.65	1.1	.0396	.024
	3	1.82	1.2	.0432	.024
1-C	4	1.7	1.4	.05	.03
	5	1.65	1.5	.054	.033
	6	1.8	1.6	.0576	.032
	7	1.7	1.8	.0649	.038
	1	1.9	1.	.036	.019
	2	1.62	1.1	.0396	.024
	3	1.8	1.2	.0432	.024
1-D	4	1.7	1.5	.054	.032
	5	1.63	1.6	.0576	.035
	6	1.7	1.8	.0648	.038
	7	1.5	1.8	.0649	.043
	1	1.85	1.8	.065	.036
	2	1.65	2.	.072	.044
	3	1.79	2.	.072	.04
2-A	4	1.6	2.1	.076	.047
	5	1.65	1.8	.065	.039
	6	1.8	1.6	.058	.032
	7	1.85	1.4	.050	.027
	1	1.9	2.5	.09	.047
	2	1.67	2.7	.0972	.058
	3	1.77	2.6	.0936	.053
2-B	4	1.8	2.8	.1008	.056
	5	1.65	2.6	.0936	.057
	6	1.8	2.2	.0792	.044
	7	1.8	1.9	.0684	.038
	1	1.7	2.9	.104	.061
	2	1.62	3.2	.1152	.071
	3	1.8	3.1	.1116	.062
2-C	4	1.6	3.	.108	.067
	5	1.62	3.	.108	.067
	6	1.7	2.7	.0972	.057
	7	1.75	2.4	.0865	.049
	1	1.8	3.1	.111	.062
	2	1.53	3.6	.1296	.085
	3	1.84	3.55	.128	.07
2-D	4	1.8	3.5	.126	.07
	5	1.63	3.2	.1152	.071
	6	1.8	3.	.108	.06
	7	1.8	2.8	.1008	.056
	1				
	2	1.67	1.7	.0612	.037
	3				
Base No. 2	4	1.7	1.6	.058	.034
	5	1.62	1.4	.05	.031
	6	1.8	1.1	.039	.022
	7	1.8	.8	.029	.016
	1	1.8	1.8	.065	.036
	2	1.72	2.	.072	.042
	3	1.75	2.2	.079	.045
3-A	4	1.8	2.2	.079	.044
	5	1.65	2.	.072	.044
	6	1.8	1.8	.065	.036
	7	1.8	1.5	.054	.03
	1	1.85	1.8	.064	.035
	2	1.74	2.2	.0792	.045
	3	1.65	2.2	.079	.048
3-B	4	1.6	2.4	.086	.054
	5	1.6	2.4	.086	.054
	6	1.8	2.2	.079	.044
	7	1.9	2.1	.076	.039
	1	1.8	1.9	.068	.038
	2	1.72	2.2	.0792	.046
	3	1.77	2.4	.086	.048
3-C	4	1.7	2.55	.092	.054
	5	1.65	2.6	.094	.057
	6	1.8	2.6	.094	.052
	7	1.8	2.5	.09	.05
	1	1.8	2.	.072	.040
	2	1.63	2.1	.0756	.046
	3	1.67	2.3	.082	.049
3-D	4	1.6	2.5	.09	.056
	5	1.62	2.8	.101	.062
	6	1.8	2.7	.097	.054
	7	1.8	2.7	.097	.054
	1	1.8	2.5	.090	.05
	2	1.7	2.9	.1042	.061
	3	1.75	2.6	.096	.053
4-A	4	1.6	2.5	.09	.056
	5	1.63	2.2	.079	.049
	6	1.7	1.8	.065	.038
	7	1.85	1.3	.047	.025
	1	1.9	3.1	.112	.059
	2	1.7	3.4	.122	.072
	3	1.75	3.1	.1116	.063
4-B	4	1.65	3.	.108	.066
	5	1.65	2.8	.101	.061
	6	1.6	2.3	.083	.052
	7	1.95	1.9	.068	.035
	1	1.8	3.4	.122	.064
	2	1.63	3.9	.1402	.086
	3	1.75	3.6	.130	.074
4-C	4	1.65	3.3	.118	.071
	5	1.67	3.2	.115	.069
	6	1.8	2.8	.101	.056
	7	1.8	2.3	.083	.046
	1	1.9	3.9	.140	.074
	2	1.67	4.3	.1548	.093
	3	1.73	3.8	.137	.079
4-D	4	1.7	3.6	.129	.076
	5	1.7	3.6	.129	.076
	6	1.8	3.4	.122	.067
	7	1.8	2.8	.101	.056
	1				
	2	1.7	2.2	.0792	.0466
	3				
Base No. 3	4	1.9	1.6	.0576	.031
	5				
	6	1.8	.9	.0324	.0179
	7	1.8	.6	.0216	.012
	1	1.7	2.6	.094	.055
	2	1.68	2.7	.0972	.058
	3	1.7	2.6	.0936	.055
5-A	4	1.7	2.3	.0828	.048
	5	1.65	2.1	.0756	.046
	6	1.7	1.7	.0612	.036
	7	1.85	1.3	.0468	.026
	1	1.67	2.6	.094	.056
	2	1.7	3.3	.1188	.07
	3	1.75	2.8	.1008	.057
5-B	4	1.7	2.8	.1008	.059
	5	1.67	2.6	.0936	.056
	6	1.8	2.4	.086	.048
	7	1.8	2.	.072	.04
	1	1.65	2.6	.094	.057
	2	1.65	3.	.108	.065
	3	1.78	3.	.108	.061
5-C	4	1.8	3.2	.1152	.064
	5	1.7	3.	.108	.063
	6	1.7	2.9	.104	.061
	7	1.85	2.5	.094	.049
	1	1.65	2.7	.097	.059
	2	1.65	3.2	.1152	.07
	3	1.75	3.	.108	.062
5-D	4	1.7	3.3	.1188	.07
	5	1.63	3.6	.1296	.08
	6	1.7	3.2	.115	.068
	7	1.95	3.1	.1116	.057
	1	1.62	2.9	.104	.064
	2	1.64	2.9	.1042	.064
	3	1.7	2.8	.1008	.059
6-A	4	1.75	2.3	.0828	.047
	5	1.65	2.	.072	.044
	6	1.8	1.6	.0576	.032
	7	1.8	1.1	.0396	.022
	1	1.6	3.2	.115	.072
	2	1.7	3.5	.126	.074
	3	1.8	3.5	.126	.07
6-B	4	1.7	2.9	.0044	.061
	5	1.63	2.8	.1008	.062
	6	1.7	2.	.072	.042
	7	1.75	1.6	.0576	.033
	1	1.55	3.6	.155	.083
	2	1.73	3.9	.1402	.081
	3	1.8	3.9	.14	.077
6-C	4	1.85	3.3	.1188	.064
	5	1.61	3.	108	.067
	6	1.8	2.5	.09	.05
	7	1.55	2.1	.0756	.044
	1	1.7	4.3	.155	.091
	2	1.7	4.	.144	.085
	3	1.6	4.	.144	.09
6-D	4	1.95	3.8	.1368	.07
	5	1.6	3.3	.1188	.074
	6	1.7	2.8	.1008	.059
	7	1.85	2.4	.086	.046
	1				
	2	1.68	2.4	.086	.051
	3				
Base No. 4	4	1.65	1.4	.050	.031
	5				
	6	1.8	.7	.025	.014
	7	1.95	.5	.018	.009
	1	1.63	2.9	.104	.064
	2	1.72	3.	.108	.063
	3	1.67	2.5	.09	.054
7-A	4	1.65	2.3	.082	.050
	5	1.65	1.8	.064	.039
	6	1.6	1.4	.050	.031
	7	1.9	1.	.036	.019
	1	1.67	3.	.108	.065
	2	1.7	3.4	.122	.072
	3	1.7	2.9	.104	.061
7-B	4	1.7	2.9	.104	.062
	5	1.63	2.7	.097	.06
	6	1.75	2.1	.075	.043
	7	1.75	1.7	.061	.035
	1	1.62	3.	.108	.067
	2	1.8	3.7	.133	.074
	3	1.8	3.6	.13	.072
7-C	4	1.82	3.2	.115	.063
	5	1.68	3.3	.118	.071
	6	1.75	2.8	.105	.058
	7	1.60	2.3	.083	.052
	1	1.62	3.1	.112	.069
	2	1.9	4.1	.148	.078
	3	1.87	4.0	.144	.077
7-D	4	1.7	3.5	.128	.075
	5	1.68	3.7	.133	.079
	6	1.8	3.2	.115	.064
	7	1.8	2.9	.104	.057
	1	1.65	2.9	.104	.063
	2	1.7	3.0	.108	.063
	3	1.82	2.6	.093	.052
8-A	4	1.7	2.	.072	.042
	5	1.65	1.5	.054	.033
	6	1.8	1.1	.039	.022
	7	1.85	.8	.028	.015
	1	1.67	3.2	.115	.069
	2	1.67	3.3	.118	.071
	3	1.72	3.	.108	.063
8-B	4	1.5	2.4	.086	.057
	5	2.1	2.2	.079	.038
	6	1.95	1.7	.061	.031
	7	1.8	1.2	.043	.024
	1	1.69	3.6	.129	.076
	2	1.63	3.6	.129	.08
	3	1.8	3.6	.130	.072
8-C	4	1.6	2.8	.10	.063
	5	2.3	2.8	.1	.043
	6	1.9	2.1	.075	.04
	7	1.75	1.6	.057	.033
	1	1.8	4.	.144	.08
	2	1.8	4.	.144	.08
	3	1.8	4.	.144	.08
8-D	4	1.7	3.	.108	.063
	5	2.3	3.3	.118	.043
	6	1.8	2.4	.086	.047
	7	1.85	1.9	.068	.037
Normal, Petticoat Pipe In	*	1.8	2.8	.1	.055
Normal, Petticoat Pipe Out	*	1.8	3.2	.115	.064
	1	2.1	2.8	.101	.04
Sliding A	2	1.7	2.7	.097	.057
	3	1.9	2.3	.082	.043
	1	1.9	2.6	.093	.049
Sliding B	2	1.7	3.	.108	.063
	3	1.9	2.8	.101	.053
	1	2.	3.2	.115	.057
Sliding C	2	1.6	3.4	.122	.076
	3	2.	3.2	.115	.057
	1	1.8	3.3	.119	.066
Sliding D	2	1.6	3.4	.122	.076
	3	1.8	3.4	.122	.068

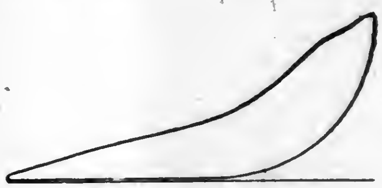
* Normal.

TABLE VIII.

FORTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	40
	R. P. M.	194.4
Pounds of Steam Used	Per Hour	12968
	Per Minute	216
Cut off	In Inches	6.4
	In Per Cent. of Stroke	26.9



M. E. P. 52.0 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed. Back Pressure, lbs.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
Base No. 1	1	2.7	1.2	.043	.016
	2	2.24	1.2	.0432	.019
	3				
	4	2.25	1.3	.0468	.021
	5	2.25	1.2	.0432	.019
	6	2.4	1.2	.0432	.018
	7	2.55	1.	.036	.014
1-A	1	2.3	1.2	.043	.019
	2	2.25	1.4	.0504	.022
	3	2.50	1.6	.0577	.023
	4	2.3	1.7	.061	.027
	5	2.22	1.7	.0612	.028
	6	2.2	1.7	.0612	.028
	7	2.45	1.5	.054	.022
1-B	1	2.2	1.4	.05	.023
	2	2.3	1.4	.0504	.022
	3	2.35	1.4	.0503	.021
	4	2.25	1.8	.065	.029
	5	2.21	1.9	.0684	.031
	6	2.4	1.9	.0684	.028
	7	2.25	1.9	.0684	.03
1-C	1	2.65	1.4	.05	.018
	2	2.23	1.4	.0504	.023
	3	2.52	1.4	.0503	.02
	4	2.05	1.7	.0612	.03
	5	2.13	1.8	.0648	.03
	6	2.2	1.9	.0684	.031
	7	2.4	2.	.072	.03
1-D	1	2.45	1.3	.047	.019
	2	2.25	1.4	.0504	.022
	3	2.4	1.4	.0503	.021
	4	2.3	1.8	.0648	.028
	5	2.22	1.9	.0684	.031
	6	2.2	2.	.072	.033
	7	2.3	2.1	.0756	.033
2-A	1	2.6	2.3	.083	.032
	2	2.27	2.4	.0864	.038
	3	2.35	2.6	.0936	.04
	4	2.	2.4	.0864	.043
	5	2.21	2.2	.0792	.036
	6	2.4	2.	.072	.03
	7	2.45	1.6	.0578	.024
2-B	1	2.4	3.1	.111	.046
	2	2.2	3.2	.1152	.052
	3	2.37	3.3	.1188	.05
	4	2.2	3.	.108	.049
	5	2.25	2.9	.1044	.046
	6	2.4	2.5	.09	.037
	7	2.4	2.2	.0792	.033
2-C	1	2.45	3.5	.126	.051
	2	2.15	3.8	.1368	.064
	3	2.38	3.7	.1332	.056
	4	2.3	3.5	.126	.055
	5	2.25	3.5	.126	.056
	6	2.2	3.1	.1116	.051
	7	2.2	2.7	.0972	.044
2-D	1	2.45	4.	.144	.059
	2	2.1	4.3	.1548	.074
	3	2.42	4.	.144	.059
	4	2.4	3.9	.1404	.058
	5	2.21	4.	.144	.065
	6	2.4	3.4	.122	.051
	7	2.25	3.2	.1152	.051
Base No. 2	1				
	2	2.33	2.1	.0756	.032
	3				
	4	2.3	1.9	.068	.030
	5	2.22	1.6	.058	.026
	6	2.2	1.2	.043	.019
	7	2.5	.9	.032	.013
3-A	1	2.6	2.3	.082	.032
	2	2.4	2.6	.094	.039
	3	2.4	2.65	.096	.039
	4	2.2	2.6	.094	.043
	5	2.23	2.4	.086	.038
	6	2.2	2.1	.076	.034
	7	2.5	1.7	.061	.025
3-B	1	2.5	2.7	.097	.039
	2	2.3	2.6	.094	.041
	3	2.5	2.9	.104	.042
	4	2.3	2.9	.104	.045
	5	2.25	2.9	.104	.046
	6	2.2	2.6	.094	.043
	7	2.65	2.4	.087	.033
3-C	1	2.5	2.7	.097	.038
	2	2.27	2.8	.1008	.044
	3	2.34	2.7	.097	.045
	4	2.3	3.1	.112	.049
	5	2.23	3.1	.112	.05
	6	2.3	3.	.108	.047
	7	2.4	2.8	.101	.042
3-D	1	2.6	2.4	.086	.033
	2	2.23	2.7	.0972	.044
	3	2.6	3.	.108	.041
	4	2.4	3.	.108	.045
	5	2.2	3.	.108	.049
	6	2.2	3.1	.112	.051
	7	2.4	3.2	.115	.048
4-A	1	2.3	.3	.108	.047
	2	2.3	3.3	.1188	.052
	3	2.35	3.	.108	.046
	4	2.2	2.9	.104	.047
	5	2.3	2.5	.09	.039
	6	2.2	2.	.072	.033
	7	2.4	1.4	.05	.021
4-B	1	2.2	3.5	.126	.057
	2	2.35	4.1	.1476	.063
	3	2.34	3.4	.122	.052
	4	2.25	3.6	.130	.058
	5	2.27	3.2	.152	.051
	6	2.4	2.7	.097	.041
	7	2.6	2.1	.076	.029
4-C	1	2.5	4.3	.155	.062
	2	2.3	4.6	.1656	.072
	3	2.28	4.	.144	.063
	4	2.3	4.	.144	.063
	5	2.34	3.7	.133	.057
	6	2.4	3.	.108	.045
	7	2.3	2.6	.094	.041
4-D	1	2.8	5.3	.191	.068
	2	2.27	5.	.18	.079
	3	2.41	4.4	.158	.065
	4	2.4	4.3	.155	.065
	5	2.4	4.2	.151	.063
	6	2.4	3.8	.136	.057
	7	2.35	3.2	.115	.049
Base No. 3	1				
	2	2.35	2.8	.1008	.043
	3				
	4	2.45	1.9	.0684	.028
	5				
	6	2.45	1.1	.0396	.016
	7	2.25	.7	.0252	.011
5-A	1	2.41	3.2	.115	.048
	2	2.33	3.5	.126	.054
	3	2.4	3.1	.1116	.046
	4	2.4	2.8	.1008	.042
	5	2.25	2.4	.0864	.038
	6	2.2	2.	.072	.033
	7	2.35	1.4	.0503	.021
5-B	1	2.37	3.2	.115	.049
	2	2.4	3.9	.1402	.058
	3	2.36	3.4	.1221	.052
	4	2.45	3.2	.1152	.047
	5	2.25	3.2	.1152	.051
	6	2.3	2.8	.1008	.044
	7	2.4	2.8	.0792	.033
5-C	1	2.3	3.2	.115	.05
	2	2.25	3.6	.1296	.058
	3	2.4	3.6	.130	.054
	4	2.4	3.7	.1332	.055
	5	2.25	3.6	.1296	.057
	6	2.25	3.4	.122	.054
	7	2.4	3.1	.1116	.046
5-D	1	2.45	3.4	.122	.05
	2	2.26	3.8	.1368	.059
	3	2.3	3.6	.13	.056
	4	2.45	4.	.144	.054
	5	2.22	3.9	.1404	.063
	6	2.3	3.8	.1368	.059
	7	2.35	3.5	.126	.054
6-A	1	2.4	3.6	.129	.054
	2	2.3	3.5	.126	.055
	3	2.2	3.4	.122	.055
	4	2.45	2.7	.0972	.04
	5	2.28	2.4	.0864	.036
	6	2.4	1.8	.0648	.027
	7	2.4	1.3	.0468	.019
6-B	1	2.27	4.	.144	.064
	2	2.33	4.2	.151	.065
	3	2.2	4.2	.151	.068
	4	2.3	3.4	.1224	.053
	5	2.24	3.	.108	.048
	6	2.15	2.4	.086	.040
	7	2.25	1.9	.0684	.030
6-C	1	2.1	4.4	.158	.075
	2	2.26	4.6	.1656	.073
	3	2.2	4.5	.162	.074
	4	2.35	3.9	.1404	.06
	5	2.27	3.4	.1224	.056
	6	2.2	2.9	.104	.047
	7	2.25	2.4	.0684	.038
6-D	1	2.1	4.8	.173	.082
	2	2.25	5.	.18	.08
	3	2.3	5.2	.1872	.081
	4	2.4	4.4	.1584	.066
	5	2.2	4.1	.1476	.067
	6	2.25	3.3	.1188	.053
	7	2.5	2.8	.1008	.04
Base No. 4	1				
	2	2.30	2.8	.1	.043
	3				
	4	2.3	1.7	.061	.027
	5				
	6	2.3	.75	.027	.012
	7	2.35	.5	.018	.008
7-A	1	2.22	3.4	.122	.055
	2	2.35	3.6	.129	.055
	3	2.13	3.	.108	.051
	4	2.33	2.7	.097	.042
	5	2.25	2.4	.086	.038
	6	2.3	1.6	.057	.025
	7	2.3	1.1	.039	.017
7-B	1	2.18	3.6	.129	.059
	2	2.25	4.2	.158	.07
	3	2.30	3.6	.130	.056
	4	2.4	3.4	.122	.051
	5	2.22	3.	.108	.049
	6	2.2	2.4	.086	.039
	7	2.2	1.9	.068	.031
7-C	1	2.21	3.6	.129	.058
	2	2.35	4.6	.166	.071
	3	2.37	4.	.144	.061
	4	2.35	3.8	.136	.058
	5	2.22	3.8	.136	.062
	6	2.3	3.2	.1156	.05
	7	2.45	2.9	.104	.043
7-D	1	2.21	3.9	.14	.067
	2	2.4	4.7	.169	.070
	3	2.3	4.2	.151	.066
	4	2.2	4.2	.151	.069
	5	2.25	4.2	.151	.067
	6	2.35	3.7	.133	.057
	7	2.35	3.5	.126	.054
8-A	1	2.22	3.5	.126	.057
	2	2.3	3.6	.129	.056
	3	2.4	3.	.108	.045
	4	2.35	2.3	.082	.035
	5	2.33	1.9	.068	.029
	6	2.30	1.25	.045	.02
	7	2.35	.9	.032	.014
8-B	1	2.25	4.1	.148	.066
	2	2.4	4.2	.151	.063
	3	2.45	3.5	.126	.051
	4	2.35	2.9	.104	.045
	5	2.5	2.4	.086	.035
	6	2.4	1.9	.068	.028
	7	2.25	1.4	.05	.022
8-C	1	1.27	4.5	.162	.071
	2	2.25	4.4	.158	.07
	3	2.4	4.	.144	.06
	4	2.25	3.4	.122	.054
	5	2.7	3.	.108	.037
	6	2.4	2.4	.086	.036
	7	2.2	1.9	.068	.031
8-D	1	2.4	4.9	.176	.073
	2	2.23	4.7	.169	.075
	3	2.4	4.2	.151	.069
	4	2.4	3.6	.130	.054
	5	2.8	3.6	.129	.036
	6	2.4	2.7	.097	.04
	7	2.25	2.3	.082	.036
Normal, Petticoat Pipe In	*	2.4	3.9	.14	.058
Normal, Petticoat Pipe Out	*	2.4	3.8	.136	.057
Sliding A	1	2.8	3.6	.129	.046
	2	2.2	3.	.108	.049
	3	2.3	2.7	.097	.042
Sliding B	1	2.6	3.0	.108	.041
	2	2.2	3.4	.122	.055
	3	2.3	3.1	.111	.048
Sliding C	1	2.6	3.5	.126	.048
	2	2.3	3.9	.140	.061
	3	2.5	4.2	.151	.06
Sliding D	1	2.4	4.0	.144	.06
	2	2.2	4.1	.147	.067
	3	2.4	4.0	.144	.06

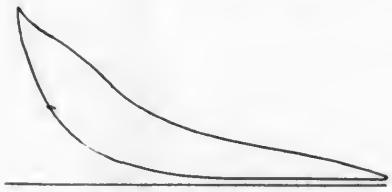
* Normal.

TABLE IX.

FIFTY-MILE SERIES.

CONSTANTS.

Speed	Miles per hour	50
	R. P. M.	243
Pounds of Steam Used	Per Hour	14194
	Per Minute	236
Cut-Off	In Inches	6.8
	In Per Cent. of Stroke	28.5



M. E. P. 41.5 lbs.

RESULTS.

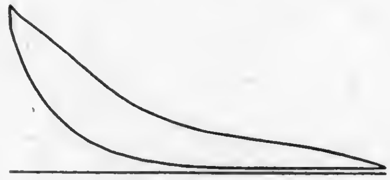
I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	3.	3.1	.115	.038
	2	2.95	3.1	.115	.038
	3	2.9	3.4	.123	.042
2-C	1	3.	4.	.144	.048
	2	3.1	3.9	.14	.044
	3	2.8	4.	.144	.051
2-D	1	3.5	5.1	.187	.052
	2	3.	4.3	.154	.051
	3	3.1	4.6	.165	.054
4-B	1	2.9	4.2	.151	.053
	2	3.	4.	.144	.046
	3	3.	4.2	.151	.05
4-C	1	3.	4.9	.176	.058
	2	2.9	4.4	.158	.054
	3	2.9	4.2	.151	.052
4-D	1	3.4	5.7	.205	.06
	2	3.	5.	.18	.06
	3	2.8	4.6	.156	.055
6-B	1	2.8	4.6	.165	.059
	2	2.8	3.2	.115	.041
	3	2.7	4.0	.144	.052
6-C	1	2.8	5.1	.183	.063
	2	2.85	4.8	.172	.061
	3	2.7	4.2	.151	.056
6-D	1	2.7	5.4	.194	.069
	2	3.	5.4	.194	.064
	3	2.6	4.6	.165	.063
8-B	1	3.	4.6	.165	.055
	2	3.1	4.3	.154	.05
	3	2.8	3.8	.136	.048
8-C	1	2.8	5.2	.187	.066
	2	3.	4.8	.172	.057
	3	3.	4.	.144	.048
8-D	1	3.	5.5	.198	.066
	2	2.9	5.2	.187	.065
	3	3.2	5.4	.194	.06
Normal Petticoat, Pipe In	Normal	3.	4.6	.165	.055
Normal Petticoat, Pipe Out	Normal	2.8	4.4	.158	.057
Sliding A	1	3.4	4.	.144	.042
	2	2.8	3.5	.126	.045
	3	2.9	3.1	.111	.038
Sliding B	1	3.2	3.6	.129	.04
	2	2.9	3.9	.140	.048
	3	3.	3.6	.129	.043
Sliding C	1	3.1	4.	.144	.046
	2	2.3	3.9	.14	.061
	3	3.4	5.2	.18	.058
Sliding D	1	3.	4.2	.151	.05
	2	2.8	4.6	.165	.059
	3	3.	4.8	.172	.057

TABLE X.

SIXTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	60
	R. P. M.	291.6
Pounds of Steam Used	Per Hour	15040
	Per Minute	250
Cut-Off	In Inches	7.2
	In Per Cent. of Stroke	30.0



M. E. P. 40.0 lbs.

RESULTS.

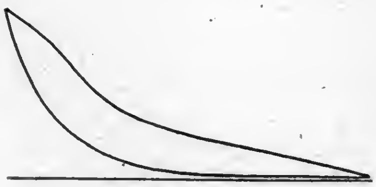
I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	3.6	3.4	.123	.034
	2	3.65	3.6	.129	.034
	3	3.5	3.8	.136	.039
2-C	1	3.5	5.1	.187	.046
	2	3.65	4.4	.158	.042
	3	3.4	4.4	.158	.045
2-D	1	4.2	5.9	.212	.05
	2	3.6	4.8	.172	.047
	3	3.5	4.8	.172	.049
4-B	1	3.5	4.9	.176	.05
	2	3.7	4.4	.158	.042
	3	3.5	4.4	.158	.045
4-C	1	3.1	5.4	.194	.055
	2	3.45	5.	.180	.051
	3	3.2	4.6	.156	.049
4-D	1	3.8	6.7	.241	.064
	2	3.7	6.6	.237	.064
	3	3.4	5.	.180	.052
6-B	1	3.5	5.1	.183	.052
	2	3.5	4.7	.168	.048
	3	3.5	4.2	.151	.043
6-C	1	3.5	5.7	.205	.058
	2	3.25	5.6	.201	.057
	3	3.5	4.8	.172	.05
6-D	1	3.5	6.2	.223	.063
	2	3.5	5.8	.208	.058
	3	3.2	5.2	.187	.059
8-B	1	3.6	5.2	.187	.051
	2	3.5	4.5	.162	.046
	3	3.2	4.	.144	.045
8-C	1	3.4	6.	.216	.063
	2	3.5	5.2	.187	.052
	3	3.6	4.6	.165	.045
8-D	1	3.9	6.4	.236	.06
	2	3.7	6.	.216	.058
	3	3.8	5.6	.201	.052
Normal Petticoat, Pipe In	Normal	3.5	5.2	.187	.053
Normal Petticoat, Pipe Out	Normal	3.2	5.	.180	.056
Sliding A	1	3.8	4.2	.151	.04
	2	3.2	3.8	.136	.042
	3	3.5	3.1	.111	.032
Sliding B	1	3.7	4.	.144	.039
	2	3.8	4.9	.140	.038
	3	3.3	3.9	.140	.042
Sliding C	1	3.4	4.6	.165	.048
	2	3.2	5.1	.183	.057
	3	3.6	5.3	.190	.052
Sliding D	1	3.5	4.8	.173	.049
	2	3.2	5.1	.183	.057
	3	3.5	5.4	.194	.055

TABLE XI.

19 PER CENT. CUT-OFF SERIES.

CONSTANTS.

Cut-Off	In Inches	4.5
	In Per Cent. of Stroke	19
Pounds of Steam Used	Per Hour	9702
	Per Minute	162
Speed	Miles Per Hour	40
	R. P. M.	194.4



M. E. P. 35.4 lbs

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	1.6	1.6	.0576	.036
	2	1.4	1.6	.0576	.041
	3	1.4	2.	.072	.051
2-C	1	1.6	2.	.072	.06
	2	1.4	2.	.072	.051
	3	1.6	2.4	.0864	.054
2-D	1	1.5	2.4	.0864	.058
	2	1.4	2.4	.0864	.062
	3	1.6	2.6	.0936	.058
4-B	1	1.5	2.2	.0792	.053
	2	1.4	2.2	.0792	.057
	3	1.5	2.4	.0864	.058
4-C	1	1.4	2.5	.0738	.053
	2	1.3	2.4	.0864	.066
	3	1.5	2.6	.0936	.062
4-D	1	1.4	3.1	.1116	.079
	2	1.4	2.6	.0936	.067
	3	1.5	2.8	.1008	.067
6-B	1	1.5	2.3	.0828	.055
	2	1.4	2.2	.0792	.056
	3	1.6	2.4	.0864	.054
6-C	1	1.5	3.	.108	.072
	2	1.4	2.6	.0936	.067
	3	1.4	2.6	.0936	.067
6-D	1	1.5	2.9	.1044	.069
	2	1.4	2.4	.0864	.062
	3	1.5	3.	.108	.072
8-B	1	1.2	2.5	.09	.075
	2	1.2	2.2	.0792	.066
	3	1.5	2.2	.0792	.058
8-C	1	1.3	2.7	.0972	.075
	2	1.4	2.6	.0936	.067
	3	1.4	2.4	.0864	.062
8-D	1	1.4	3.2	.1152	.082
	2	1.4	3.6	.1296	.093
	3	1.4	3.	.108	.076
Normal Petticoat, Pipe In	Normal	1.4	2.4	.086	.051
Normal Petticoat, Pipe Out	Normal	1.2	2.4	.086	.072
Sliding A	1	1.4	2.0	.072	.051
	2	1.1	1.9	.068	.062
	3	1.3	1.6	.057	.044
Sliding B	1	1.2	2.	.072	.06
	2	1.4	2.1	.075	.053
	3	1.4	1.9	.068	.048
Sliding C	1	1.2	2.	.072	.06
	2	1.2	2.4	.086	.071
	3	1.2	2.3	.082	.068
Sliding D	1	1.4	2.2	.079	.056
	2	1.3	2.4	.086	.066
	3	1.4	2.3	.082	.058

TABLE XII.

26.9 PER CENT. CUT-OFF SERIES.

CONSTANTS.

Cut-Off	In Inches	6.4
	In Per Cent. of Stroke	26.9
Pounds of Steam Used	Per Hour	12988
	Per Minute	216
Speed	Miles Per Hour	40
	R. P. M.	194.4

M. E. P. 50.1 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	2.4	2.6	.0936	.039
	2	2.4	2.6	.0936	.039
	3	2.3	3.	.108	.047
2-C	1	2.4	3.2	.1152	.043
	2	2.4	3.2	.1152	.052
	3	2.4	3.5	.1098	.046
2-D	1	2.4	4.2	.1512	.063
	2	2.4	3.8	.1368	.057
	3	2.5	4.4	.1584	.063
4-B	1	2.2	3.5	.1260	.057
	2	2.2	3.4	.1144	.052
	3	2.4	3.6	.1296	.054
4-C	1	2.5	4.3	.1546	.062
	2	2.5	4.	.144	.058
	3	2.5	4.	.144	.058
4-D	1	2.4	5.3	.1908	.079
	2	2.3	4.2	.1512	.066
	3	2.5	4.4	.1584	.063
6-B	1	[illegible]	3.7	.1322	.055
	2	2.2	3.7	.1332	.06
	3	2.4	3.6	.1296	.054
6-C	1	2.3	4.3	.1548	.067
	2	2.4	4.2	.1512	.063
	3	2.5	4.2	.1512	.065
6-D	1	2.2	4.7	.1692	.077
	2	2.5	4.4	.1584	.061
	3	2.4	4.4	.1584	.066
8-B	1	2.4	4.	.144	.06
	2	2.2	3.8	.1368	.062
	3	2.4	3.4	.1224	.051
8-C	1	2.5	4.6	.1656	.066
	2	2.4	4.2	.1512	.063
	3	2.4	3.8	.1368	.056
8-D	1	2.4	5.	.18	.075
	2	2.6	4.8	.1728	.066
	3	2.4	4.2	.1512	.063
Normal Petticoat, Pipe In	Normal	2.4	3.9	.140	.058
Normal Petticoat, Pipe Out	Normal	2.4	3.8	.136	.057
Sliding A	1	2.8	3.6	.129	.046
	2	2.2	3.	.108	.049
	3	2.3	2.7	.097	.042
Sliding B	1	2.6	3.	.108	.041
	2	2.2	3.4	.122	.055
	3	2.3	3.1	.111	.048
Sliding C	1	2.6	3.5	.126	.048
	2	2.3	3.9	.140	.061
	3	2.5	4.2	.151	.060
Sliding D	1	2.4	4.	.144	.06
	2	2.2	4.1	.147	.067
	3	2.4	4.	.144	.06

TABLE XIII.

35 PER CENT. CUT-OFF SERIES.

CONSTANTS.

Cut-Off	In Inches	8.4
	In Per Cent. of Stroke	35.0
Pounds of Steam Used	Per Hour	17330
	Per Minute	289
Speed	Miles Per Hour	40
	R. P. M.	194.4

M. E. P. 65.4 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	4.	4.3	.1548	.038
	2	4.	4.2	.1512	.038
	3	4.	4.6	.1656	.041
2-C	1	4.	5.	.18	.045
	2	4.	5.	.18	.045
	3	4.	5.4	.1944	.048
2-D	1	4.	6.5	.2340	.058
	2	4.	6.	.216	.054
	3	4.3	6.	.216	.05
4-B	1	4.	5.9	.2124	.053
	2	4.2	5.4	.1944	.046
	3	4.3	5.2	.1872	.044
4-C	1	4.	7.	.252	.063
	2	4.1	6.4	.2304	.056
	3	3.9	6.	.216	.055
4-D	1	4.2	7.6	.2736	.065
	2	4.2	6.6	.2376	.054
	3	4.2	6.2	.2232	.053
6-B	1	3.8	6.3	.2268	.059
	2	4.2	6.8	.2448	.058
	3	4.	5.8	.2088	.052
6-C	1	4.	6.7	.2415	.06
	2	3.8	6.9	.2304	.061
	3	4.	6.	.216	.054
6-D	1	3.9	7.6	.2736	.07
	2	4.2	7.4	.2664	.063
	3	4.	7.	.252	.063
8-B	1	4.2	6.6	.2376	.056
	2	4.3	5.9	.2124	.049
	3	3.8	5.	.18	.047
8-C	1	4.2	7.2	.2592	.062
	2	4.	7.	.252	.063
	3	4.	5.8	.2088	.052
8-D	1	4.	7.8	.2808	.07
	2	4.	7.6	.2736	.068
	3	4.	6.4	.2304	.057
Normal Petticoat, Pipe In	Normal	4.	5.7	.202	.051
Normal Petticoat, Pipe Out	Normal	4.	5.8	.208	.052
Sliding A	1	3.9	5.2	.187	.048
	2	4.4	4.8	.172	.039
	3	4.8	4.	.144	.03
Sliding B	1	3.8	5.2	.187	.049
	2	4.2	5.1	.183	.043
	3	4.4	4.9	.176	.04
Sliding C	1	4.	5.7	.205	.051
	2	4.4	6.3	.226	.051
	3	4.7	6.2	.223	.047
Sliding D	1	4.	6.2	.223	.055
	2	4.2	6.2	.223	.058
	3	4.8	6.2	.223	.046

CONVENIENT LOCOMOTIVE RECORD.

DEVISED BY G. R. HENDERSON.

This engraving is from a photograph of a convenient and compact locomotive record in the office of Mr. G. R. Henderson, superintendent of motive power of the Santa Fé. Each locomotive on the road is represented by a block of wood 2 ins. square by ¼ in. thick. On each edge of the block is the engine number, classification and tractive power. Each of the four edges is painted with a color representing the condition of the engine. White signifies "good"; blue, "fair"; green, "poor," and yellow, "awaiting the shop." The blocks are arranged in columns in an open case, where they are easily examined and moved about or turned around. Index blocks, thicker than the others, indicate the various shops or divisions, and the blocks are placed under these indexes as desired. For instance, the block marked

2247 S 14,950

refers to switch engine No. 2247, having a tractive effort of 14,950 lbs. The block may be placed under "Topeka Shop," or "Chicago Division," or "Reserve," or "Scrapped." The color of the edge of the block which is exposed to view indicates its

A CONVENIENT LOCOMOTIVE RECORD.

condition, and its location in the case shows its location on the road. Every month the whole record is revised by a clerk and the "condition" indications brought up to date. Every week the location record is revised. "Good" condition means that the engine will give 90 days or more of efficient service; "fair" means that an engine is good for from 30 to 90 days of service; "poor" means "shop in 30 days."

Mr. Henderson devised this record system while he was with the Chicago & Northwestern, and it is still being used there very satisfactorily. Mr. Henderson has extended it also to the condition of cars. A large case in the car-department office provides blocks for all the passenger cars on the road. There is sufficient space for three years' records, and each column represents a month. The colors of the blocks represent classes of cars, as follows: White, mail; yellow, chair; green, smokers; blue, chair; drab, combination, and pink, dining cars. The four sides of the blocks indicate that a car is in the shop for repairs of one of four classes, according to which side is exposed. These are indicated as follows: Class A, general overhauling and painting, repaneling, or the original paint burned off; class B, general overhauling and painting, without burning off old paint; class C, general overhauling and applying one coat of coach color, re-striping and varnishing; class D, general overhauling, with paint touched up and varnished.

It would seem to be difficult to devise a more elastic, compact and convenient system than this for keeping a record of a large amount of equipment. The case shown in the engraving is about 4 ft. long by 3 ft. high and perhaps 3 ins. deep from the wall. It is a part of an admirable system by which Mr. Henderson may inspect at a glance the condition of his work.

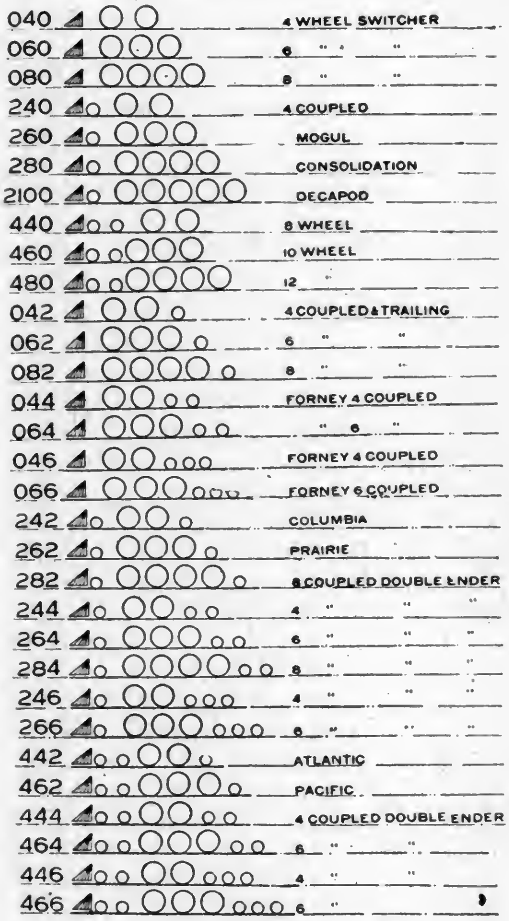
WHYTE'S LOCOMOTIVE CLASSIFICATION.

ADOPTED BY THE AMERICAN LOCOMOTIVE COMPANY.

The engineering department of the American Locomotive Company, under the direction of Mr. J. E. Sague, mechanical engineer, has adopted the Whyte locomotive classification, devised by Mr. F. M. Whyte, of the New York Central, and explained by him on page 56 of this journal for February, 1901.

A plan was desired which would be simple, universal, easily understood and easily used. It is based upon the representation, by numerals, of the number and arrangement of the wheels of a locomotive, beginning at the front. Thus 260 means a "mogul" and 460 a "ten-wheel" engine, the cipher denoting that no trailing wheels are used. These numerals may be separated by hyphens or they may be placed consecutively.

WHYTE'S LOCOMOTIVE CLASSIFICATION.
Adopted by American Locomotive Company.



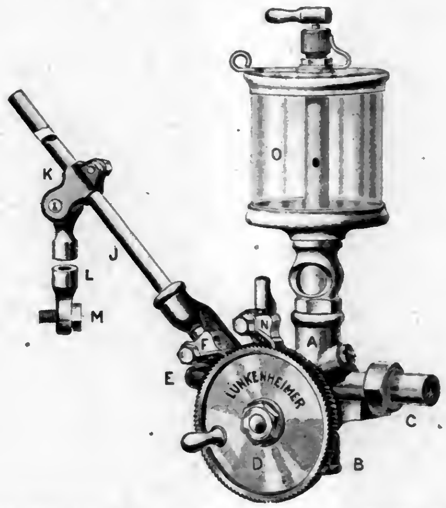
Thus far the classification is merely a substitute for the old method of referring to different wheel arrangements by popular names, a custom which has given us the "Central Atlantic," "Northwestern," "Chautauqua" and "Atlantic" types for the same wheel arrangement. It has also given us the "Pacific," the "Mountain" and "St. Paul" types for another wheel arrangement, with other perplexing nomenclature.

In order to include in the classification some definite factor which will convey an idea of the character and size of a locomotive, the American Locomotive Company adds the total weight of the engine expressed in thousands of pounds. Thus an Atlantic type locomotive weighing 176,000 lbs. will be classed as a 442-176 type. If the locomotive is compound, the letter "C" will be subsututed for the hyphen, and the classification will be written 442C176. Locomotives with tanks on the main frames, instead of separate tenders, will be indicated by the letter "T" in place of the hyphen. Thus a double-end suburban locomotive with a two-wheel leading truck, six drivers and a six-wheel rear truck, weighing 214,000 lbs., will be represented by 266T214.

This action of these locomotive builders is to be commended. The accompanying diagram indicates the new beside the old classification.

LUNKENHEIMER MECHANICAL OIL CUP.

A new positive, mechanically operated oil cup has been perfected by the Lunkenheimer Company, of Cincinnati, Ohio. Oil from the glass reservoir is fed to a small pump below, through a sight feed glass, and all the oil which comes down must necessarily be delivered to the desired destination. The pump is driven by the crankpin mechanism (H and G in the engraving) and the piston rod E. A lever (J) is driven by the fittings attached to it, and the ratchet-wheel D is advanced by a certain number of notches, as determined by the stroke, which depends upon the position of the fitting K. The lubricator is mounted upon a stand and placed in a convenient location where it may be driven from the engine, the oil pipe being connected from the tube C to the steam chest or cylinder. A check valve is placed in the oil connection to secure satisfactory working of the device. In starting the engine, if more oil is desired, the ratchet-wheel may be turned by hand. The ratchet-wheel and pawls are of hardened tool steel, all other metal parts being of hard bronze composition.

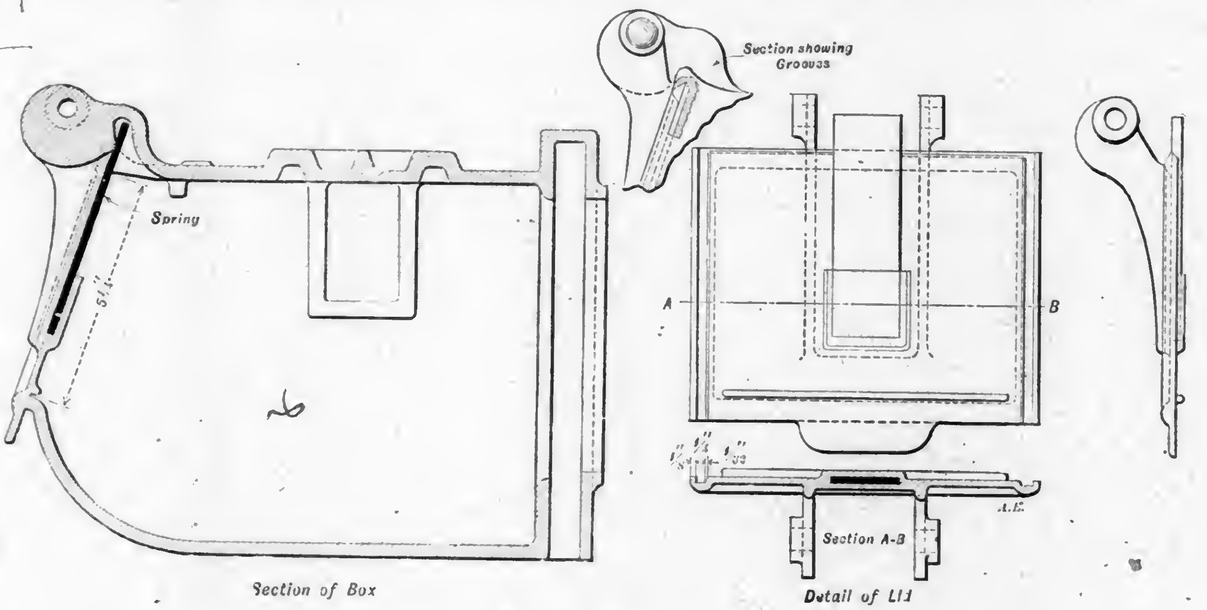


LUNKENHEIMER MECHANICAL OIL CUP.—FRONT VIEW.

Tests at partial and full loads have been made by Prof. Jacobus of Stevens Institute of Technology upon a Rice & Sargent, cross-compound condensing engine at the Brooklyn plant of the American Sugar Refining Company. The engine had 20.03 and 40 by 42-in. cylinders, and the average clearance in the cylinders was 4 per cent for the high pressure and 6.8 per cent for the low pressure. It was provided with a reheating coil in the receiver which was supplied with steam at boiler pressure. The condenser was of the Bulkley pattern and the engine drove a direct connected Bullock generator, the speed being 120 rev. per min. The tests showed a water consumption of 12.10 lbs. per horse-power-hour at 627 horse-power and 12.75 lbs. at 1,004 horse-power. At 491 horse-power the water consumption was 13.9 lbs. and at 339 horse-power it was 14.58 lbs. These figures represent the total water consumption, including that used in the jackets and the reheater coil. The complete record of the tests, including a description of the calibration of the electrical measuring instruments, is continued in a pamphlet issued by the Providence Engineering Works, Providence, R. I.

THE SHARP JOURNAL BOX.

The journal box was designed and patented by Mr. W. E. Sharp, of the Armour car lines, with a view of reducing the amount of trouble from hot boxes. It is constructed with a tight lid, which is held tightly closed by a spring fitted into the lid so that it will press the lid against its seat, and yet when the lid is fully open the spring is out of the way and it may remain open. The spring is straight and is secured by a dovetail bit in the lid itself. The engravings illustrate the fitting of the lid against the projecting top of the box and also the grooves in the cover at the sides. These tend to keep out dust, which is undoubtedly the cause of a large proportion of the hot boxes. To prevent dirt from entering the box at the inside face, the dust guard slot opens on the under side. These boxes have been in service for more than a year, giving satisfactory results. They are manufactured by the Holland Company, 77 Jackson Boulevard, Chicago.



THE SHARP JOURNAL BOX.

EDUCATIONAL DEPARTMENTS OF THE NEW YORK CITY Y. M. C. A.

The educational departments of the various New York City branches of the Young Men's Christian Association have this season met with large enrollments in the classes in which both day and evening instruction is given at convenient hours. Among the subjects taught are the following: Arithmetic; algebra; geometry; free-hand, architectural and mechanical drawing; bookkeeping and commercial law.

The courses of study are all carefully adapted to meet the requirements of those who have not had the opportunity of higher education, but who wish to better themselves by study outside of working hours, and particular care is exercised for the individual wants of each student. A large portion of the enrollment in the mechanical drawing class this year is from the ranks of practical machinists, metal workers, and even tracers from draughting offices, who find the demands of the times to require of them their best efforts. Also many of the students in mechanical drawing are those who have had instruction from correspondence schools with not entirely satisfactory results, and have found it far more desirable to work with the assistance of, and in the presence of, an instructor.

It is of unquestionably far greater advantage to study with an instructor than by the correspondence school method, and we earnestly recommend any one desiring instruction, who can have access to the Y. M. C. A. schools, to avail himself of the same instead of the correspondence method.

The building of the Twenty-third Street Branch, which is the oldest, and the parent of all, has recently been sold, and a new building is now in process of erection on the same street between Seventh and Eighth avenues. It is to cost when completed about $850,000, and will undoubtedly be the most complete association building in the world. In this building class rooms capable of accommodating over 700 students in day and evening classes will be arranged.

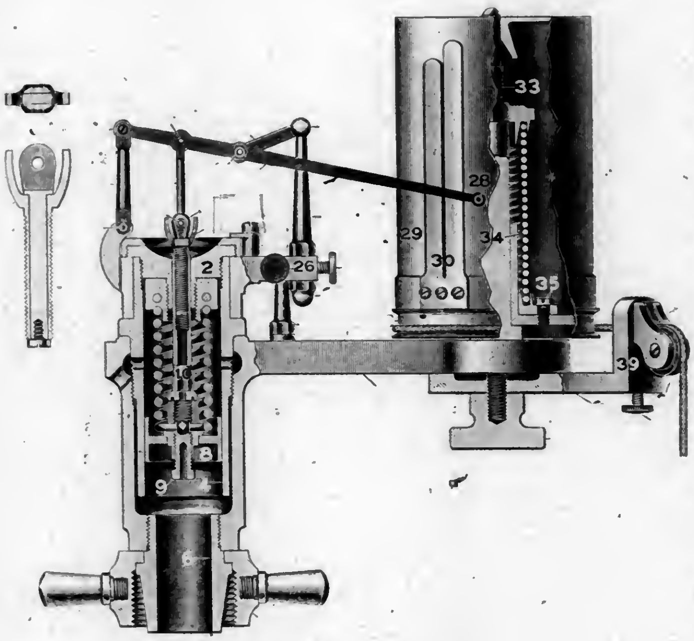
The Vulcan Shipbuilding and Engineering Company, of Germany, builders of the "Kronprinz Wilhelm," the "Kaiser Wilhelm der Grosse" and others of the trans-Atlantic fleet of the North German Llyod Steamship Company, has selected a new location for its shipbuilding yard and works on the River Elbe, near the North Sea. The company has for some time been hampered in constructing and handling the modern mammoth ocean liners at its former works at Stettin, on the River Oder, by the shallow draft of the water in the latter river, as well as in its outlet, the Baltic Sea itself. The intention is, at first, to build only the large vessels at the new works, the engines for the same, and as far as possible the boilers also, to be supplied by the Stettin works.

A remarkably strong recommendation for the chilled cast-iron carwheel comes from the Central Railroad of New Jersey. It appears that out of 8,000 wheels under 1,000 50-ton steel cars built for that road by the Pressed Steel Car Company but 6 wheels were found to be defective in 21 months of continuous service. This amounts to 0.75 of 1 per cent. These and other interesting figures on this subject were presented by Mr. Streicher, of that road, at the February meeting of the New York Railroad Club.

An air-lift pumping plant using the Pohle system of piping and raising water 267 ft. is described in a recent number of *Compressed Air*. The plant is at Grinnell, Iowa, the wells are 2,000 ft. deep and the discharge is at the rate of 136 gals. per minute.

THE STAR IMPROVED STEAM ENGINE INDICATOR.

This instrument combines good features of other instruments of its kind with a number of valuable new ones. Its frame is strong and rigid. The pencil motion is of the well-known Thompson type, which was selected because of its satisfactory features of rigdity and lightness. The spring terminates in a ball, as in all instruments of the Richards type. The cylinder is removable from the frame, and is steam-jacketed to prevent unequal expansion. Instead of screwing into the outer shell, the cap is threaded into the interior of the top of the cylinder itself, thus securing perfect alignment of the piston-rod. A hard rubber covering is secured to the cap, having a milled edge, this material being non-conducting and permitting of handling without the least discomfort. Another feature of this kind is a tube to conduct away the steam and hot water from the top of the cylinder, so that the operator's hand will not be burnt. These conveniences are sure to be appreciated. To adjust the height of the pencil, a threaded swivel head is provided for the piston-rod, and the atmospheric



STAR IMPROVED INDICATOR.

line may be brought to any desired location on the card. This instrument has an improved clutch detent attachment and a helical spring for driving the drum. By a few easily made changes the instrument may be changed from right to left hand. The Star Brass Manufacturing Company, 108 East Dedham street, Boston, are the manufacturers. They are equipped with machinery and have expert mechanics, their indicator department being in all respects upon the high plane of their other well-known specialties.

A profit-sharing plan has been put into effect by the Pressed Steel Car Company for the benefit of its employees. The company will carry for each of its employees who has been in its service six months, and whose application is approved by the general manager, from one to twenty-five shares of the company's preferred stock, according to the wages or salary of the employee. An initial payment of 5 per cent. on the stock must be made, followed by monthly payments of the same amount. As interest on the deferred payments will be charged at only 4 per cent., and the stock pays 7 per cent., the employees have the advantage of the difference of 3 per cent.

CAST-IRON WHEELS AND BRAKESHOES.

"Keep down the braking load and the necessity of much braking effort, and you will help the cast-iron wheel; increase either the speed or load, or both, and the wheels will suffer if they are not proportionately strengthened. For the same amount of braking in the same period of time, I believe that a shoe of soft cast-iron will heat the cast-iron wheel to a less extent than any other shoe in common use, for the reason that considerable heat must be dissipated in the particles which are thrown off the shoe in an incandescent state. Apparently the softer cast iron allows the passage of heat through the body of the shoe, whereas the more ductile, flowing metals, as wrought iron and mild steel, as well as the harder and more dense chilled and hard cast iron, apparently hold back the heat and maintain a higher temperature at the face of the shoe and consequently a higher temperature at the wheel-face. As brakshoe makers, our efforts have been directed toward retaining, as much as possible, the soft cast-iron effect in the brakeshoe, toughening it by inserts to resist rapid wear as well as to increase the grip on the wheel. We have been compelled, however, in order to meet to-day's requirements, to reinforce the cast-iron body by the addition of a steel back as a safeguard against failure in the shoe by cracking. The cast-iron wheel cannot, unfortunately, be reinforced in the same manner as the brakeshoe, and the wheelmakers can only add more weight in the rim and plate and improve the quality of the metal. The records of test on cast-iron wheels under the 80,000-lb. and 100,000-lb. capacity freight cars indicate that the cast-iron wheel of to-day is equal to the increased demand when the braking load is based on the light weight of the car. What will happen to the cast-iron wheel from the brakeshoe acting with a load based on the total weight of the loaded car is a question yet to be decided.

"In conclusion, and returning to the consideration of the cast-iron wheel to meet to-day's requirements from the standpoint of the relation between the brakeshoe and the wheel, the use of a flanged brakeshoe—bearing on the wheel-tread and flange, the shoe supported against failure by a steel back—will materially assist the successful operation of the best cast-iron wheel that can be made."

These are the concluding paragraphs in a paper by Mr. F. W. Sargent, read at the February meeting of the New York Railroad Club. The paper should be carefully read by everyone who is interested in the operation of trains and the maintenance of equipment.

THE ESSENTIALS OF A GOOD DRAFT GEAR.

I. A drawbar of the strongest material to resist blows, jerks, etc., with secure attachment to transmit stresses received.

II. Adequate yielding resistance with minimum recoil, securely housed.

III. Fixed attachments of the car strong and well designed for ease of inspection of the gear, and well secured to the car so as to distribute and dispose of all stresses as advantageously as possible.—Mr. E. M. Herr, in a paper before the Railway Club of Pittsburgh.

BOOKS AND PAMPHLETS.

Locomotives: Simple, Compound and Electric. By H. C. Reagan, Locomotive Engineer. Fourth Edition. 578 pp., Illustrated. John Wiley & Sons, 43 East Nineteenth street, New York. 1902. Price, $2.50.

The author is a locomotive engineer and writes for locomotive engineers and firemen. He describes boilers, cylinders, frames, rods, valve motion, the compound locomotive, safety valves, in-

jectors and boiler fittings, air brakes, and an appendix is devoted to the electric locomotive. With few exceptions, he contents himself with descriptions and does not get down into the important principles. A large amount of the matter is already available from manufacturers' catalogues.

That this book is in its fourth edition indicates that it has had a good reception, but to the reviewer this appears to be for lack of a better book rather than because of great merit in itself. It contains new matter, but does not reflect the most important progress of the locomotive since the appearance of the previous edition. Its value lies chiefly in a presentation of descriptions of various systems of compounding, in suggestions with respect to emergency repairs for cases of breakdown, and in an elementary discussion of electric locomotives, supplemented by engravings of a number of such locomotives. The good features of the book are prominent, but they stand out from a lot of matter much of which is old and indifferently presented. The locomotive is worthy of the best work of which any author is capable, and this book should be revised and completed. It should be brought up to date with respect to present tendencies of design. A lot of obsolete matter should be discarded and present day practice presented in its place. The probable reason why we have no satisfactory book on the locomotive is that in order to be up to date such a work needs to be completely revised every few years. In spite of these criticisms we are glad to see any book upon the locomotive. Engineers and firemen are eager students and faithful readers. They should therefore have the best that can be produced.

History of the Nottingham & Lincoln Railway—a paper by Mr. Clement E. Stretton, of Saxe Coburg House, Leicester, England.—The author traces the history of this road from the incorporation of the Midland Railway in 1844, the line of which was extended, by advice of George Stephenson, to Nottingham and Lincoln. Mr. Stretton is to be commended for his faithfulness in placing on record many portions of the important early history of railroad development which would otherwise be forgotten and concealed by the swift progress of transportation. In connection with the account the author says: "Finally, the Jessop 'edge-rail-way' from Loughborough to Nanpantan was opened in June, 1789, being the first line upon which the inside flanged wheel was used. The fact that Mr. Jessop first decided to have an outside gauge of 5 ft. and then changed to an inside gauge without altering the rails is, of course, the reason why we to-day have a gauge of 4 ft. 8½ ins. In other words, it is 5 ft. less the width of two of Jessop's rails. All modern railway vehicles, it is common knowledge, have a flange upon the inner side, and it is equally certain that without the flange railway traffic would be impossible, as the Outram idea of a ledge upon the rail to keep the wheels upon the track would be useless for other than horse traction, or a speed of more than six or seven miles an hour. Mr. Jessop's great invention was, therefore, in 1788 to introduce and make at the Butterley works the flanged wheel and the edge rail. The fact that William Jessop was the inventor of the flanged wheel, and that he, by placing the flange inside, made the railway gauge 4 ft. 8½ ins., as it is at present, is an interesting point in railway history, and it is pleasing to know that some of the original rails are preserved in the South Kensington Museum, the Leicester Museum and at the Loughborough Free Library.. Thus, at Loughborough originated two most important inventions, viz., the edge railway and the 4 ft. 8½-in. railway gauge, which latter gauge has become almost universal."

Of a large number of calendars received this year from manufacturing concerns, two are worthy of special mention, one from the Brady Brass Company and the other from the American Steam Gauge and Valve Manufacturing Company. Both of these are unusually artistic and attractive.

"Cranes of Different Kinds" is the title of a handsomely printed pamphlet received from Maris Brothers, Philadelphia, builders of hand and electric traveling cranes. In a few pages of well-written description, accompanied by engravings, the reader finds the product of the company, and its purposes, presented with the minimum expenditure of his time and trouble. This pamphlet is from the advertising shop of Clarence P. Day, 140 Nassau street, New York. Its unique character and attractive appearance cannot fail to compel careful examination by those into whose hands it comes.

The board of directors of the Allis-Chalmers Company, in a meeting held January 15, declared the regular quarterly dividend on the preferred stock.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, gave a banquet at the Union League Club, Chicago, January 12, to the representatives of the company in the United States and Canada. It was held at the close of the business meeting on the occasion of the second annual gathering of these representatives in Chicago. Mr. J. W. Duntley received a loving cup and Mr. W. O. Duntley a handsome watch from the representatives of the sales department of the company. In connection with the meeting, a committee of the directors visited all of the plants on a trip of inspection. It was evident that greatly enlarged facilities must be provided to meet the immediate demand for increased product.

The American Blower Company, Detroit, Mich., have distributed an illustrated circular describing the heating plant for the Natural Food Company, Niagara Falls, N. Y., in which the "A. B. C." system is employed. The building is 463 ft. long, and in all has an area of 5½ acres of floor space. The heating system supplies 4,500,000 cu. ft. of volume with a change of air every 15 minutes, and in some portions every 7½ minutes. Three 200-in. steel-plate fans are employed.

The Pedrick & Ayer Company, for a great many years located at Philadelphia, Pa., have removed to Plainfield, N. J., and are now occupying their new works which they have just completed, the main building of which is 400 ft. long and 100 ft. wide, with independent power-house, blacksmith shop, pattern shop and pattern storage. This new shop has been equipped with electric traveling cranes and modern tools so as to enable them to meet the largely increased demand for their standard goods, for which they have made such a reputation, consisting of air compressors, air hoists, pneumatic riveters, and special railroad tools. Their selling office is at 85-87-89 Liberty street, New York City.

The Baldwin Locomotive Works built 1,532 locomotives in the year 1902, 1,375 in 1901 and 1,217 in 1900. The best year prior to 1900 was 1890, with an output of 946 locomotives. Of the 1,532 built last year 74 were electric, 424 were compounds and 25 were fitted to burn oil. The number built for export was 99. Owing to the demand at home the number exported was very much smaller than usual.

The Phosphor-Bronze Smelting Company (Limited), 2200 Washington avenue, Philadelphia, have issued a newly revised price list, No. 21, of their well-known "Elephant Brand" phosphor-bronze. It is stated that this company is constantly adding to and improving its facilities to meet the increasing demands for their product. The pamphlet gives sizes and thicknesses of phosphor bronze sheet metal, wire, circles, rods, wire ropes, ingots, castings, alloys and "hardenings." Those using this material should procure this revised list of prices and secure the latest discount.

The Falls Hollow Staybolt Company, of Cuyahoga Falls, Ohio, have appointed the Republic Railway Appliance Company, of St. Louis, as their agents for the Southwest. Mr. E. S. Marshall is president of the latter company, and from his experience as superintendent of motive power of several important roads is specially well qualified to present the merits of this staybolt iron. He has used "carloads" of it himself. The manufacturers of this product, in a recent communication, say: "We are pleased to announce that the year just closed has been the banner year for us and the outlook for 1903 is still better. Falls Hollow Staybolt iron is fast increasing in favor owing to its many advantages over the solid or drilled bolt. We furnish solid staybolt iron made of the same high grade, double refined charcoal iron, as the hollow, to those who prefer solid material."

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

RAILWAY SHOPS.

BY R. H. SOULE.

II.

GENERAL CONSIDERATIONS.

Before taking up the different departments in detail it would be well to consider those more general questions which, in a problem of shop design, always precede the actual mapping out of the several buildings. The location is the first of these, and it naturally becomes fixed at what might be called, in a transportation sense, the center of gravity of the district or system to be served. This is always a terminal or division point, and often a junction point as well. This consideration usually outweighs the question of labor and material supply, which otherwise would be the determining factor. It seldom has happened that shops were designed first, and a corresponding plot of land purchased subsequently; on the contrary, railway companies have usually anticipated the actual planning of new shops by acquiring available property adjacent to their right of way and otherwise favorably located. This has sometimes resulted in extremes, such as a nearly square tract of land, or, on the contrary, a long, narrow strip. The former condition is found at the Burnside (Ill.) plant of the Illinois Central Railroad, and the latter exists at the Horwich shops of the Lancashire & Yorkshire Railway of England. Either condition is a restraint on the free grouping of buildings and arrangement of track approaches; at both places very clever solutions have been found, however. The ratio of length to breadth in a plot of ground thus reserved for shop purposes should preferably fall between these extreme limits. The acreage should be liberally ample, and when the exact layout plan has been decided on, and space reserved for all possible extension, the surplus land, if any, may be disposed of. In such a case, restrictions may be placed on the property sold, and the character of the neighborhood thus guaranteed, to a certain extent. Access to a group of shop buildings by other means than railway tracks being desirable, a public road (if one does not already exist) should be laid out along one edge of the property. Gifts of land for shop purposes, or contributions towards its cost, should not be too hastily accepted; title to such lands may come into question later on, if the railroad company modifies its manner of using the same. Two such cases, within the knowledge of the writer, have occurred on American railways within the last ten years.

The shop site having been chosen and the land provided, the character and quantity of work to be done in the completed plant must be determined or assumed. This will usually crystallize out into a certain number of locomotives and cars, passenger and freight, to be maintained, or built, or both, per unit of time, usually per month. It is safer to proportion the shops on the basis of the greatest output likely to be required during any one month of the year, than it is to work on the basis of assuming the monthly output to be simply one-twelfth of the desired yearly output. The trend of organization, resulting from the general experience of railways, being towards merging the locomotive and car departments under one control, the typical railway central repair plant will comprise all of the several shops which are required in either connection. Separate locomotive and car repair plants may, of course, be justified where work of each kind is prosecuted on a large scale, or on account of special or local considerations. In the more general case of the combined shop, however, certain of the departments can be used jointly for both locomotive and car work; such, for instance, are the storehouse, the machine shop, the smith shop, the foundry, the carpenter shop, and the paint shop. This list of joint shops emphasizes the fact that great economy can, in general, be accomplished by the concentration of the work of locomotive and car repairs into one group of buildings, as otherwise at least five of these six sub-departments (the foundry being possibly excepted) would have to be duplicated. When there is but one such group of buildings, yard service, whether by switching engine or laboring gang, can also be economized.

One-story buildings are always to be preferred if concentration does not have to be sacrificed. Day lighting and internal transportation are both easier to accomplish in one-story structures. The only exception to the general principle is in the case of those few departments where the work is light, such as the tin shop and the upholstery shop. The office and storehouse buildings may be, and generally are, of two-story construction, however. In this connection it must be acknowledged that artificial lighting, under present conditions, is so cheap and satisfactory that the shutting off of daylight does not reduce output as much as in the old days of oil lamps and torches.

Having determined the number of departments to be provided for, and the amount of work to be done, each must be considered separately and the essential dimensions fixed upon; but the grouping and relative arrangement of departments must be constantly borne in mind. Labor saving devices are of first importance as features to be incorporated in the original design of a building; next in importance is the providing of such facilities of every sort as will guarantee that the labor which cannot be saved but must be expended shall be used and applied under conditions of maximum efficiency and economy. The logic by which improvement investments are justified is simply a satisfactory demonstration that interest depreciation and repairs will totalize less than the wages of unassisted labor would have amounted to in accomplishing the same result. A very satisfactory rule which is in use on one of our western lines is that any proposed improvement which will save labor amounting to 10 per cent. of its cost will be favorably considered. The credit of this company being on a 3 per cent. basis, it is argued that such a transaction is virtually a 7 per cent. investment.

Each building having thus been worked out as a problem by itself, the grouping and layout can be considered. The evolution of recent years has tended towards bringing together under one roof such departments as are mutually dependent on one another, and have a continuous interchange of materials. The smith shop and the foundry are generally isolated on account of the smoke and dust which results from their operation. Buildings which must be separated, but which house departments which are dependent upon one another, should be kept as close together as possible. Modern practice tends toward restricting such inter-shop space to from 40 to 60 ft. While due regard must be given to the question of fire risk, it must not be allowed to exclusively dominate the situation, as in a recent case on an eastern trunk line where an insurance company which had issued a blanket policy notified the railroad company that a proposed new erecting shop must not be within 100 ft. of any adjacent building.

A prime requisite in planning railway shops is that the preliminary work shall be done by some one who has become familiar, by actual experience, with the operation of such

shops. The architect has no legitimate place in this preliminary work, and his services, if needed at all, may be availed of when structural details and embellishments require attention. But the mechanical engineer and the civil engineer can cope with the bulk of the problems involved.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

REPORT BY PROFESSOR W. F. M. GOSS.

SECTION VI.

DISCUSSION OF RESULTS.

(Continued from page 76.)

35.—A Basis of Comparison.—In outlining the tests, it was proposed to base all comparisons upon the efficiency of the jet, and efficiency was defined as the ratio of back pressure to draft (See paragraph 5). The assumption of such a measure is based upon the fact that the result which is sought by the use of any combination of draft appliances is a reduction of pressure within the front-end, and that the force effecting such a reduction of pressure is a function of the pressure of steam in the passage between the cylinders and the exhaust tip. The maintenance of considerable pressures in the exhaust passages tends to reduce the economic performance of the engine, hence it is desired that the necessity for such pressures be, so far as practicable, avoided. The proposed measure of efficiency takes all this into account, for by its use that arrangement of apparatus which will give a desired reduction of pressure in the front-end in return for the least back-pressure will be the most efficient. Such a conception is perfectly logical. It is not new, but on the contrary is one which has been many times employed in the study of draft appliances.

The preceding statement is general in its application. It applies not only to the tests under consideration but to all tests which may be made for the purpose of determining the value of this or that draft appliance. It happens, however, that in the experiments under consideration, the exhaust tip was of the same size for all tests. Furthermore, it appears as one of the significant results obtained from the tests that a change in the height of the exhaust-pipe does not affect the back-pressure by a measurable amount. Consequently, so far as the present study is concerned, the back-pressure for any given condition of running appears as a constant; and the efficiency which, in the general case, is a function of both back-pressure and draft, is left to depend upon draft alone. In other words, the changes which were made in the stack and exhaust-pipe arrangement, in the process of carrying out the series of experiments under consideration, were not such as affected the back-pressure. A change in the diameter of the exhaust tip would have done this, but through the present work a fixed diameter of tip was employed. All this being true, it appears that effects resulting from changes in the front-end mechanism, such as were involved by the experiments under consideration, are quite as well shown by a direct comparison of draft values as by a comparison of efficiency values. Moreover, the draft values involve a single observation made under conditions favorable to accuracy, and consequently they supply a better basis for comparison than efficiency, which depends on two observations, one of which is rather difficult to obtain with accuracy. In view of these considerations, it has seemed wise to depart from the original outline which requires that comparisons be based on efficiency, and adopt a new plan by virtue of which comparisons shall be based on draft alone. It will be noted that in all the work which follows, this has been done, though in the tabulated statement of data, for the convenience of those who may wish to compare the results herewith presented with those obtained by other experimenters, values for efficiencies are presented for each test.

Thus far, however, justification for basing comparisons on draft rather than upon the ratio of back-pressure to draft, rests entirely upon assertions concerning the existence of a definite relation between draft and back-pressure, the truth of which it will now be well to consider.

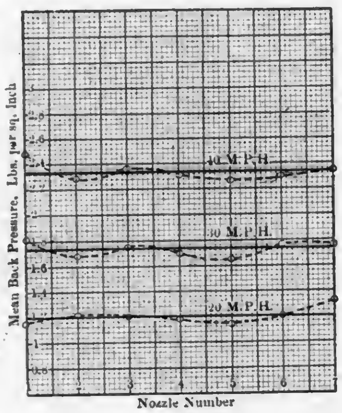


FIG. 30.

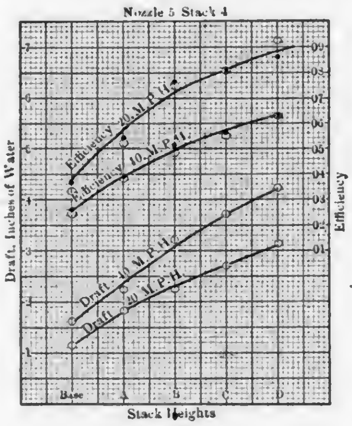


FIG. 31.

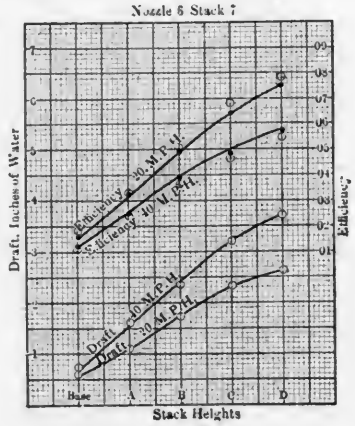


FIG. 32.

36.—Relation Between Draft and Back-Pressure as Disclosed by Tests.—It was to have been expected that changes in the stack would have little or no effect upon the back-pressure, but it has not before been shown that an increase of 30 ins. in the length of the exhaust pipe would produce no measurable change in back-pressure. A direct comparison of back-pressures as obtained from different lengths of exhaust pipes under similar conditions of running, is presented as Fig. 30. In these diagrams, the nozzle heights are plotted along the horizontal axis, the verticals representing back-pressure. Observed back-pressures are denoted by circles, and the mean values of the back-pressure obtained by averaging all of the observed values taken during the tests, with each of the seven heights of nozzle, are represented by full lines. The result of such a comparison shows that none of the average values vary from the mean of all values by more than 6 per cent, and, considering the difficulty experienced in obtaining reliable readings of the back-pressure gauges, it is entirely justifiable to assume that the straight lines drawn as indicated in the figure referred to fairly represent the true back pressure.

The usual formula for efficiency, as already defined, is

$$E = \frac{D}{P} = \frac{1}{P} D$$

in which E is the efficiency, D the draft, and p the back-pressure. But it has just been shown that for any given cut-off and speed, the tests under consideration show the back-pressure p, to be constant. Hence $\frac{1}{p}$ is a constant, and E in the equation is directly proportional to D, which is mathematical proof that comparisons based on draft will have the same significance as those based on efficiency.

For the benefit of those to whom the preceding demonstration does not appeal, the fact may be made to appear more simple when shown graphically as Fig. 31. In this figure, the draft curves obtained with a given nozzle (No. 5) and the several heights of stack at speeds of twenty and forty miles per hour, are plotted and drawn as full lines. Above these draft curves are values representing efficiency calculated in the ordinary manner from observed data with results represented by solid dots. These are to be compared with corresponding points obtained by multiplying draft values by a constant, based on the average back-pressure, with results indicated by circles on or near the efficiency curves. A very close agreement between the two sets of points is thus disclosed. A similar presentation involving data from another height of nozzle (No. 6) and another stack (No. 7) is presented as Fig. 32, and any of the experimental data similarly plotted will give substantially the same results. It is evident from an inspection of the diagrams (Figs. 31 and 32) that the efficiency curves and draft curves are substantially identical in form, and hence values represented by one are proportional to corresponding values represented by the other. As a means by which to compare results of tests, therefore, either may be used with equal advantage, and for reasons which have already been stated, use will be made of the draft in the discussion which is to follow.

37.—A Study of Results by Means of Plotted Curves.—Having presented the data obtained from the tests of stacks, it had been the intention of the undersigned to proceed at once with a presentation of conclusions derived therefrom. It has been suggested, however, by certain gentlemen who have assisted in the advancement of the work that there should be some diagrammatic presentation of the results. It has been urged that such a presentation would permit the effect of the various changes to be at once seen and would give at a glance a measure of relative values. In compliance with this suggestion, and with the assent of the AMERICAN ENGINEER, such an exhibit is herewith presented. (Figs. 33 to 88.)

With reference to this exhibit, the following should be noted. First, that all curves are plotted in terms of draft as measured in inches of water and stack diameters. As four different heights of stacks were employed, there are four series of curves for each height of nozzle, and as seven heights of nozzles were employed, there are twenty-eight diagrams for each form of stack. Each group of four figures represents all diameters of stacks for a given nozzle. Figures, therefore, from 33 to 60, inclusive, represent straight stacks and Figs. 61 to 88, inclusive, represent taper stacks.

(To be continued.)

The New York Central & Hudson River Railroad has found it necessary to provide a special organization to conduct its extensive electrical application in and near New York City. This work will be in charge of a commission consisting of Mr. W. J. Wilgus, fifth vice-president; Messrs. B. J. Arnold, F. J. Sprague, George Gibbs, and A. M. Waitt. Mr. E. B. Katte, electrical engineer, will have charge of the electrical and mechanical work and will report to the commission. Mr. Katte is succeeded as mechanical engineer of the chief engineer's department of the road by Mr. A. J. Slade, who will have charge of the work in connection with heating, lighting, power plants, and fuel and water supply stations.

THE INFLUENCE OF TIME ELEMENT ON MECHANICAL AND TRANSPORTATION MATTERS.

BY H. T. HERR,

MASTER MECHANIC, NORFOLK & WESTERN RAILWAY.

A great deal has been written on the subject of "Ton Mile Statistics" and voluminous data have been and are now prepared on this subject for the information of officers and employees of railways and for current reports for the general public.

Until within a comparatively short time, records of performance were generally based on engine mileage in relation to mechanical matters and train mileage in relation to transportation matters. The use of the ton mile for statistics may be said to be of recent origin, or at least its adaptation to general statistics has existed for a comparatively short time. That ton mileage is of more value in studying operating statistics than either the engine mile or train mile, in recognizing efficient operation, in giving a fairer comparison and a truer measure of what the road has done, will not, I think, be questioned.

Analyzing a few current terms familiar to most railway men and determining a unit of measure for general comparison, which shall combine the various elements entering strictly into the movements which occur on railroads in general, leads to the following discussion.

We require for our major premises these considerations:

First—Assume the railway established and that maintenance of the permanent way shall not be considered.

Second—Traffic cannot be moved without the expenditure of power.

Third—Power involves three elements, viz., force, distance and time.

Fourth—Work involves two elements, viz., force and distance.

Fifth—The commodity in which a railway deals is the moving of traffic.

Sixth—The cost of fuel and wages of train and engine men constitutes a majority of the expenses of moving traffic, supervision of conducting transportation representing but a small percentage.

Seventh—Cost of fuel and wages of train and engine men is variable, dependent on the traffic moved and the time.

Eighth—Cost of supervision is practically constant, between wide limits, i. e., independent of traffic moved.

Ninth—Independent of the maintenance of equipment, which should vary almost directly as the traffic moved and the time, efficient operation will obtain when the greatest traffic is moved with the least expenditure for fuel and wages of train and engine men with a proper relation to the time of movement of the traffic.

In considering the probable capacity of a railway as a common carrier two things are of vital importance, viz., the motive power and equipment. Recent conditions on many roads have indicated that the traffic was far beyond the capacity of facilities of power and equipment to move it, and it has not been uncommon for railway officers in general to hear the terms "Shortage of power" and "Shortage of equipment." Engines have frequently been loaded beyond capacity in the attempt to move freight when equipment was obtainable, with consequent serious delays. Employees have spent long hours on the road to prevent congestion, working on the last end of their trips with only half a will, making the movement of their trains probably less expeditious than if they had a pecuniary incentive to make every effort to reach the terminal with as

heavy tonnage as could be handled and with as rapid dispatch as possible.

Recent conditions have naturally given large figures on the ton mile basis, as the element of time is eliminated in a measure, and indeed on the present basis of pay for train and engine men, economy in operation is obtained unless the hours on the road are so excessive as to increase the cost of running such trains, per 1,000 ton miles, due to overtime made by the crews.

What would be the result as shown by ton mile statistics if the element of time were considered, and how would this affect the wages of the men handling the trains and the movement of traffic and equipment for the public and the road?

Assume, for example, one division of a railway 100 miles in length and equipped with certain Class A engines, rated at 1,000 tons.

Case I.—Train and engine crew A can take with a Class A engine 1,000 tons over a 100-mile division in 10 hours.

Case II.—Train and engine crew B can take with a Class A engine 1,000 tons over the same division in 8 hours. Obviously the ton mileage of both trains (100,000-ton miles) is identical, as is also the engine and train mileage. There is no question, however, as to which crew has done the better work, assuming the dispatching and other conditions the same in both cases.

Case III.—Suppose train and engine crew C takes the same tonnage over the same division, under similar conditions, in 12 hours.

In Case III. the ton mileage (100,000-ton miles) is the same as in Cases I. and II., but the cost to the railway company per 1,000-ton miles is greater for wages in Case III. than in Cases I. or II., assuming that the crews draw overtime after 10 hours on the road. The cost for wages per 1,000-ton miles in Cases I. and II. is identical, yet we have the apparent anomaly that the men who do the best work derive less pecuniary benefit from the company than the men who do the poorest, unless it be considered that crew B is relieved earlier.

Assume now that these crews are to be paid for work they actually do, which results in a direct benefit to the railway company, i. e., combine the elements time, distance and force for a basis of pay.

Case Ia—A makes 100,000-ton miles in 10 hours or 10,000-ton miles per hour.

Case IIa—B makes 100,000-ton miles in 8 hours or 12,500-ton miles per hour.

Case IIIa—C makes 100,000-ton miles in 12 hours or 8,333-ton miles per hour.

If the crews were paid on a unit basis of "1,000-ton miles per hour," crew B would earn more money for themselves and the company than either A or C, the latter earning the least. The above was assumed for a 100-mile division of a railway, and if applicable to this portion it should be applicable to the road as a whole.

Assume that the road has 10 such divisions with similar conditions applicable to each and handled by three classes of men as outlined above. In through traffic over the entire line the following would obtain:

Case Ib—Crew A makes 1,000,000-ton miles in 100 hours.

Case IIb—Crew B makes 1,000,000-ton miles in 80 hours.

Case IIIb—Crew C makes 1,000,000-ton miles in 120 hours.

Equating the three cases to the basis of what crew C can do by making the element of time equal:

Case Ic—Crew A makes 1,200,000-ton miles in 120 hours.

Case IIc—Crew B makes 1,500,000-ton miles in 120 hours.

Case IIIc—Crew C makes 833,300-ton miles in 120 hours.

It is apparent therefore that but little more than half the equipment and power is needed to move the same traffic with crew B as with crew C. This, of course, will apply equally well under the present conditions of ton mileage, but would not employees running trains and engines over the road be stimulated to haul heavy tonnage and make better time if their rate of pay was based on a power basis instead of a mileage or time basis? Would not continual complaints from engine and train crews remedy difficulties on the road which cause delay now? Would not dispatchers make every effort to avoid delays to escape the annoyance and extra work caused by continual complaints which would originate with the men if delayed on the road? Would the motive power department have any peace if their engines and rolling stock were not maintained in first-class condition? Would not the same stimulating effect be apparent on the maintenance of way department to keep slow orders, etc., to a minimum? Would not the employees engaged in running the trains be on the alert to discover means and ways to move greater tonnage in less time and each become an inspector for defects that might cause delays? Would not the incompetent soon be discovered by his fellow employees and forced to retirement? Would the railway suffer extreme loss in case of delay? Would not the tonnage rating of engines for economical loading and speed soon adjust itself to the most efficient loading of the power? Would not the statistics compiled on a power basis be the true measure of the output of the railway and applicable to motive power accounts as well as conducting transportation?

Should motive power not be maintained on a basis of power (1,000-ton miles per hour) instead of on a basis of work (1,000-ton miles) or a basis of distance (mileage), as heretofore?

In fact, would a ton mile per hour basis for statistics not be elastic and fully applicable to the determination of all statistics in which the movement of trains is considered, and result in economy and efficiency both in a financial and educational manner for the railway and its employees?

If a full and impartial discussion of this subject through the medium of this journal can be obtained the object of this article will be accomplished.

WHAT "BIG ENGINES" MEAN.

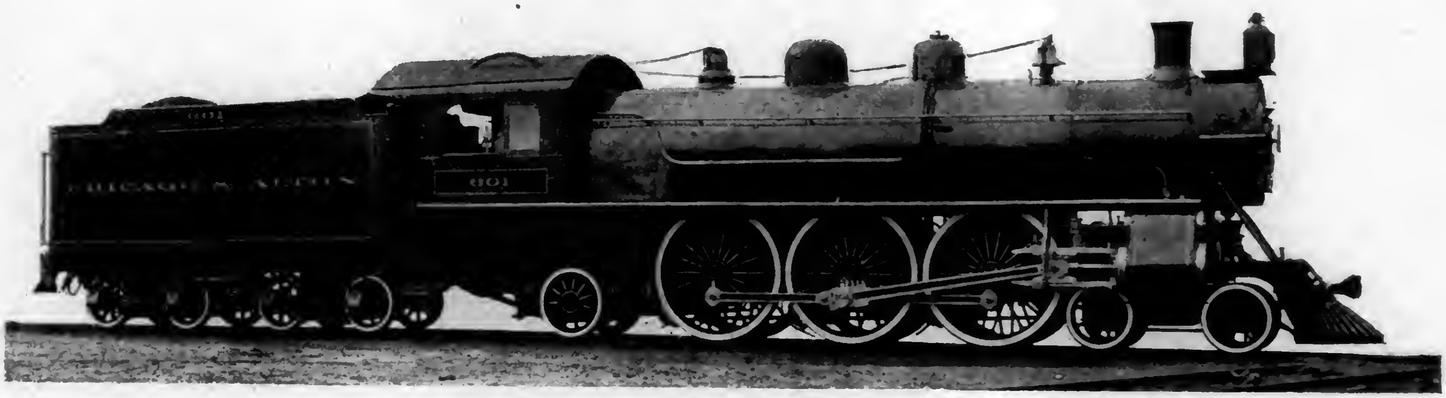
The new passenger locomotives for the Chicago & Alton described in this issue surpass all previous designs in size, weight and capacity. They have 4,078 sq. ft. of heating surface and carry 220 lbs. boiler pressure. They weigh 219,000 lbs. and have 141,700 lbs. on drivers, with 15,000 lbs. added to one of them by a traction increaser. One of them can produce a draw-bar pull of over 34,000 lbs., and this is for passenger service. In the details of construction are found 10 x 12-in. main driving journals and 7 x 7-in. crankpins for the main rod connections. There is nothing of the monstrosity order about these engines. They were built to do certain definite work which the most powerful passenger engines previously built cannot do. It must therefore be granted that such enormous proportions are necessary. There is nowhere the least hopeful sign that passenger equipment will decrease in weight or that requirements of passenger service will be less rigorous. This means that the railroads will soon be face to face with inadequate facilities for dealing with many heavy engines and the problem of efficient and sufficient shops becomes more vital and more important every year. The locomotive is to-day in advance of the tracks, the bridges, the side-tracks, the water service, the car-draft gear and the shops, and this is a situation requiring the immediate attention of the business men who are directing the operations of railroads. In the matter of shops allow us to direct attention to the fact that many built within the past two years are already "back numbers." It will not be long before the ability of railroad officers will be measured by their treatment of this problem. The advent of such large and heavy engines, which is suggestive of the necessity of quick and economical work in maintenance, calls attention to this subject in a new and forcible way.

POWERFUL PASSENGER LOCOMOTIVE.

4—6—2 TYPE.

CHICAGO & ALTON RAILWAY.

The Baldwin Locomotive Works have built for this road two passenger locomotives which head the list of designs for this service, with reference to weight, power and heating surface. They are intended especially for very heavy and comparatively slow passenger excursion trains to be run in connection with the approaching exposition in St. Louis. One of them has 80-in. drivers and the other 73-in., the latter being equipped with a modified Player traction increaser which transfers about 15,000 lbs. from the leading and trailing trucks to the driving wheels. The accompanying photograph, drawings and comparative table give an excellent idea of the proportions and power of these remarkable locomotives. It is interesting to note that though the front tube sheet is well back, the tubes are 20 ft. long, thus fulfilling the prophecy of Mr. Vauclain of two years ago. The smoke-box is 101 ins. long. Those who have been striving to reduce the size of smoke-boxes will watch the effect of this feature with interest. The tender, having capacity for 8,400 gals. of water and 9 tons of coal, is the largest ever built at the Baldwin Works. It should be stated that before deciding upon the proportions of these engines the officers of the road borrowed the heaviest and most powerful passenger engines in the country, and from exhaustive tests decided that none of them would meet the conditions required. This meant that a larger than the largest



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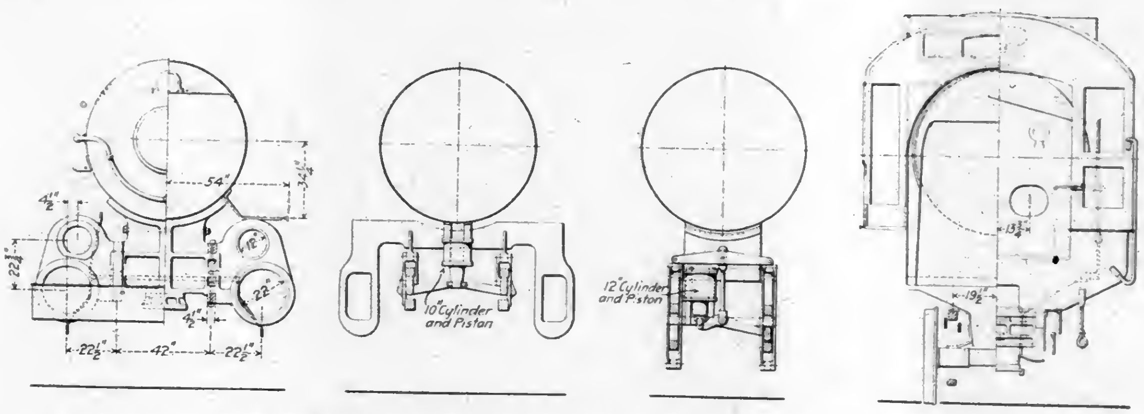

THE TRACTION INCREASER CYLINDERS ARE LOCATED IN FRONT OF FIRST AND IN REAR OF THIRD DRIVING AXLES.
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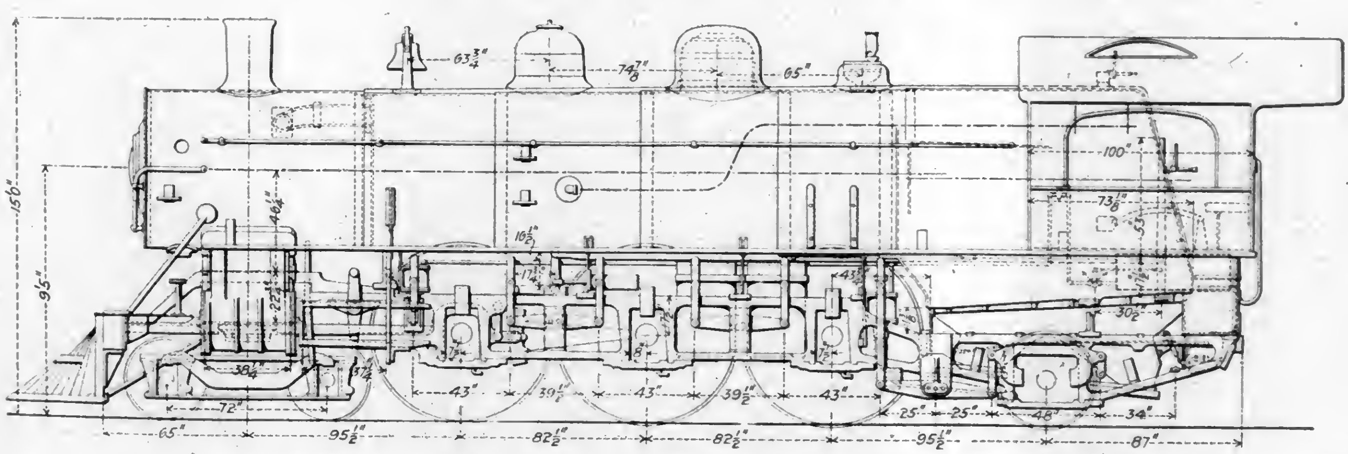

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A. L. HUMPHREY, *Superintendent of Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

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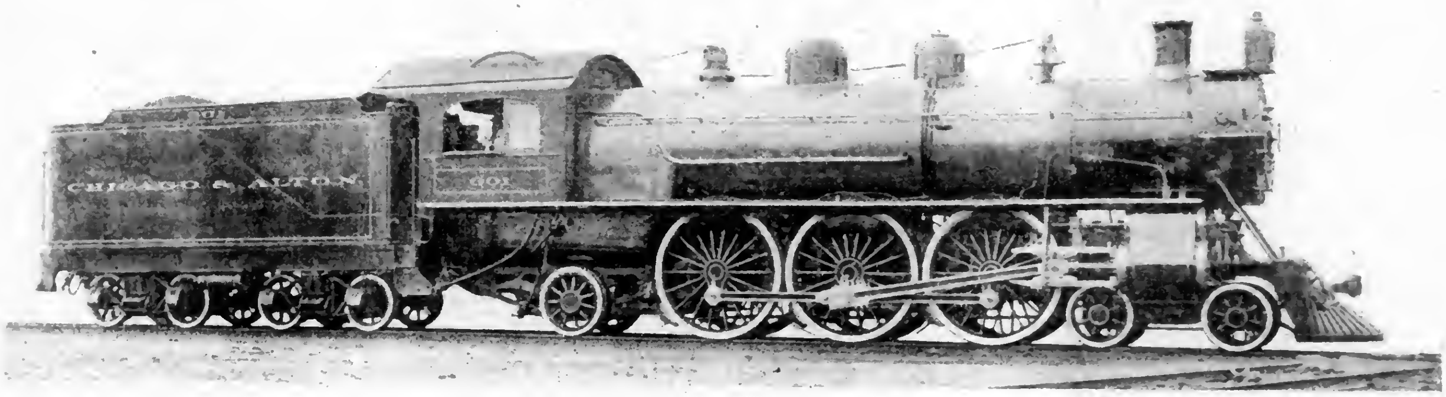

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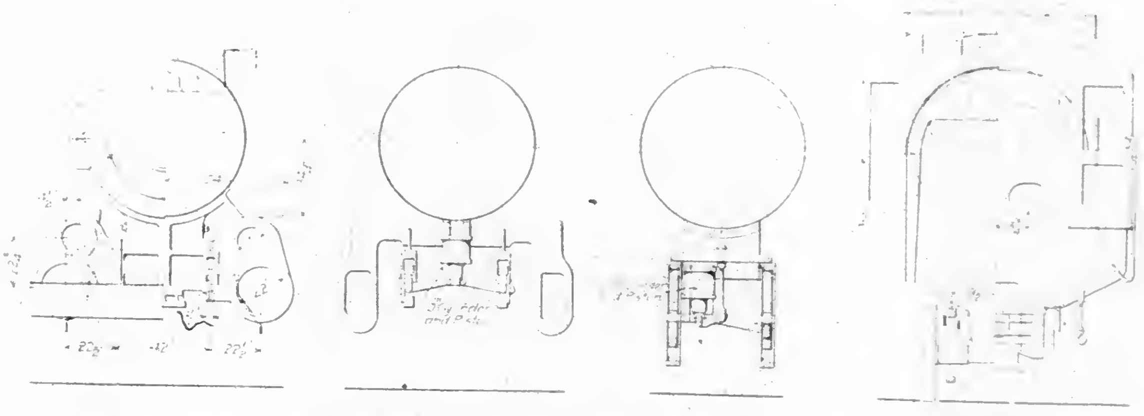

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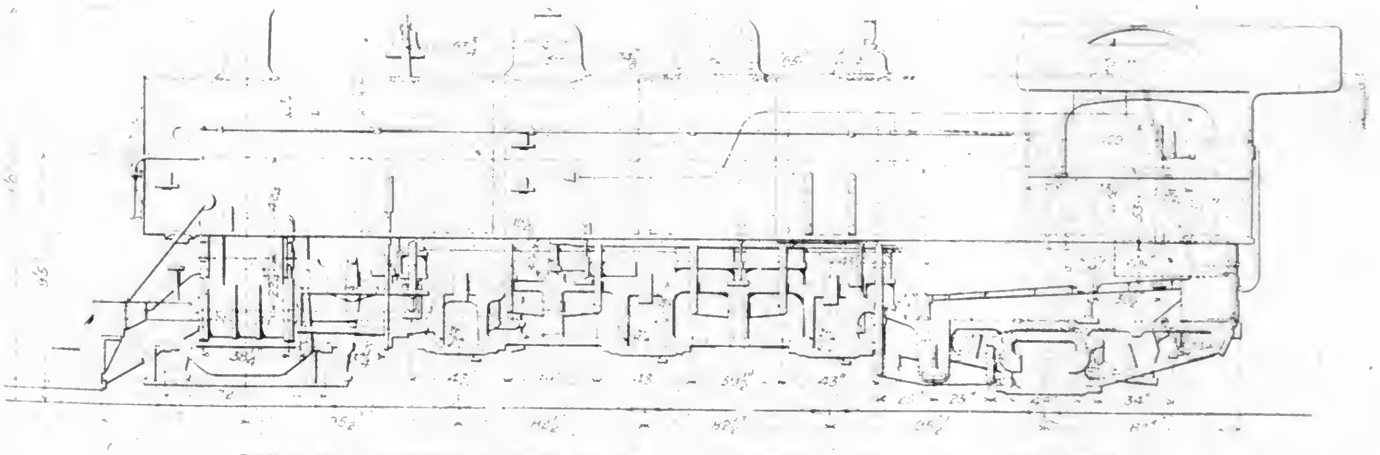

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must be built, which explains the great advance in weight and heating surface over previous practice. These enormous locomotives were therefore built for definite conditions involving trains of twenty or more cars, and not in any sense to surpass others in size.

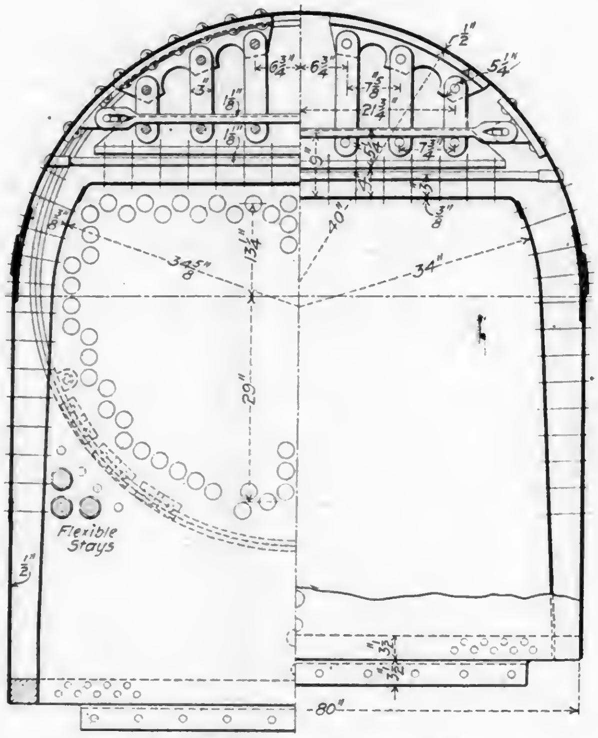
The trains these engines are to haul will consist of twelve passenger cars and weigh approximately 600 tons, without passengers and baggage. This train will accommodate conveniently 760 people, which would increase the weight 57 tons, and, allowing 15 tons for baggage, would make the train weigh nearly 675 tons. The distance this train is to be hauled is 110.6 miles, and is to be made in 2½ hours, including two stops and three slow-ups for railroad crossings. Making an allowance of six minutes for all stops, the actual running time would be 2 hours and 24 minutes. This would mean an average speed of 46 miles per hour. Before deciding on the size of engines to do this work a test was made between three different Prairie type engines, one a four-cylinder compound and the other two simple engines. The most important dimensions of these three different engines are as follows:

No Engine.	Size of Cylinders.	Diameter of Drivers.	Inside Diameter of Boiler.	Size of Fire-box.	Steam Pressure.	Grate Area.	Total Heating Surface.	Weight on Drivers.	Tractive Power.
	ins.	ins,	ins.	ins.	lbs.	sq. ft.		lbs.	
1	17 & 28 x 28	69	70	71¼ x 108	200	53.5	3,738	141,600	31,537
2	20½ x 28	80	64¾	84 x 85	200	48.6	3,343	130,000	24,990
3	20 x 28	75	66½	72 x 102	200	51.	3,534	140,200	25 386

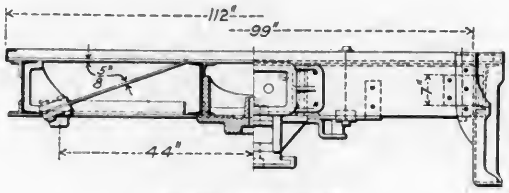
The conclusion reached from the test was that to do this work an engine about 15 per cent. more powerful than engine No. 2 was needed, and these heavy engines were designed accordingly.

RATIOS, CHICAGO & ALTON 4—6—2 TYPE.

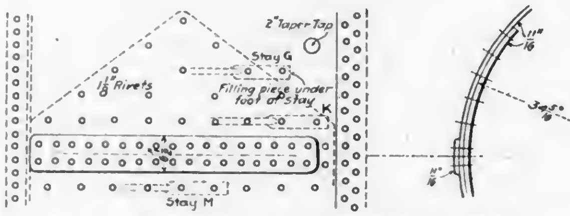
Tractive effort 80-in. wheels	31,600 lbs.
Tractive effort 73-in. wheels	34,600 lbs.
Heating surface to cylinder volume	331.00
Tractive weight to heating surface	34.74
Tractive weight to tractive effort (80-in.)	4.48



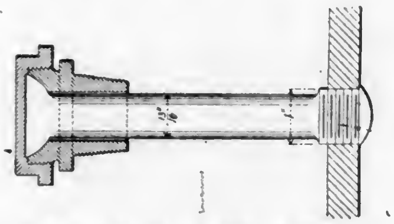
THE FIRE BOX, SHOWING CROWN STAYING.



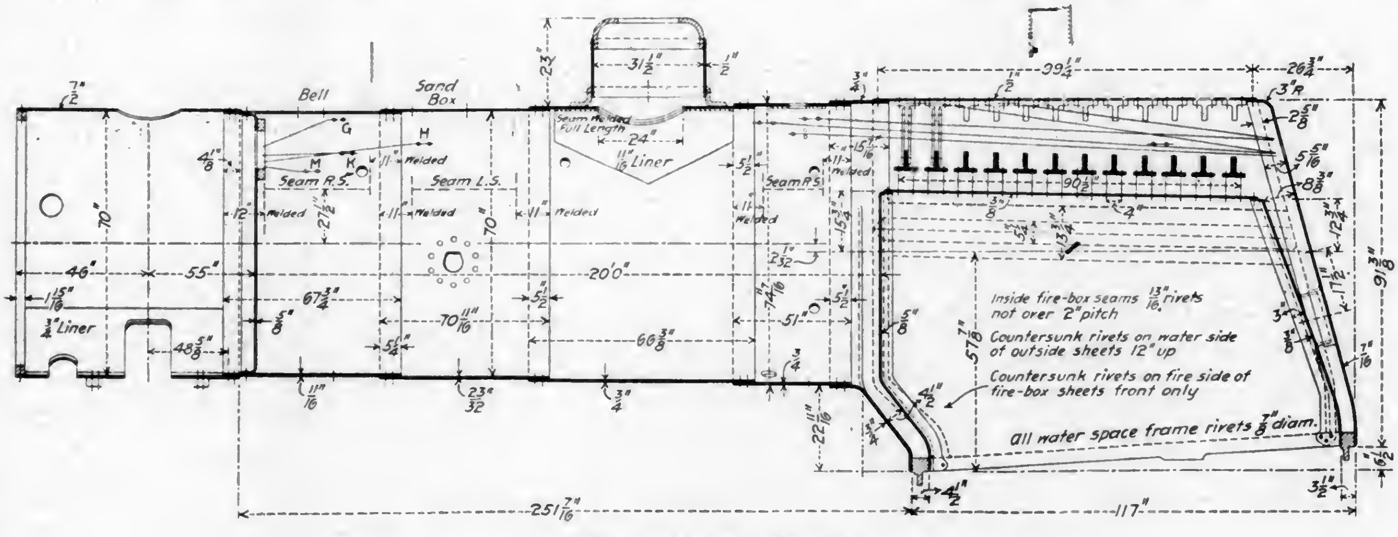
TENDER BODY BOLSTER.



SEAM IN FRONT COURSE (SEE LONGITUDINAL SECTION.)



FLEXIBLE STAYBOLT USED IN THROAT.



LONGITUDINAL SECTION OF BOILER.

POWERFUL PASSENGER LOCOMOTIVE.—CHICAGO & ALTON RAILWAY.

Tractive effort to heating surface	7.74
Heating surface to grate area	75.5
Tractive effort × diameter of drivers to heating surface	619.2
Heating surface percentage of tractive effort	12.8
Total weight to heating surface	53.7

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

Name of Road.	Engine Number.	Total Weight (Lbs.)	Total Heating Surface (Sq. Ft.)	Total Weight Divided by Heating Surface.
Chicago & Alton	601	219,000	4,078	53.7
Santa Fe	1000	190,000	3,738	50.1
New York Central	2980	176,000	3,505	50.2
Chesapeake & Ohio	147	187,000	3,533	52.9
Lake Shore	650	174,500	3,343	52.2
Chicago & Northw't'n	1015	160,000	3,015	53.1
Northern Pacific	284	202,000	3,462	58.3

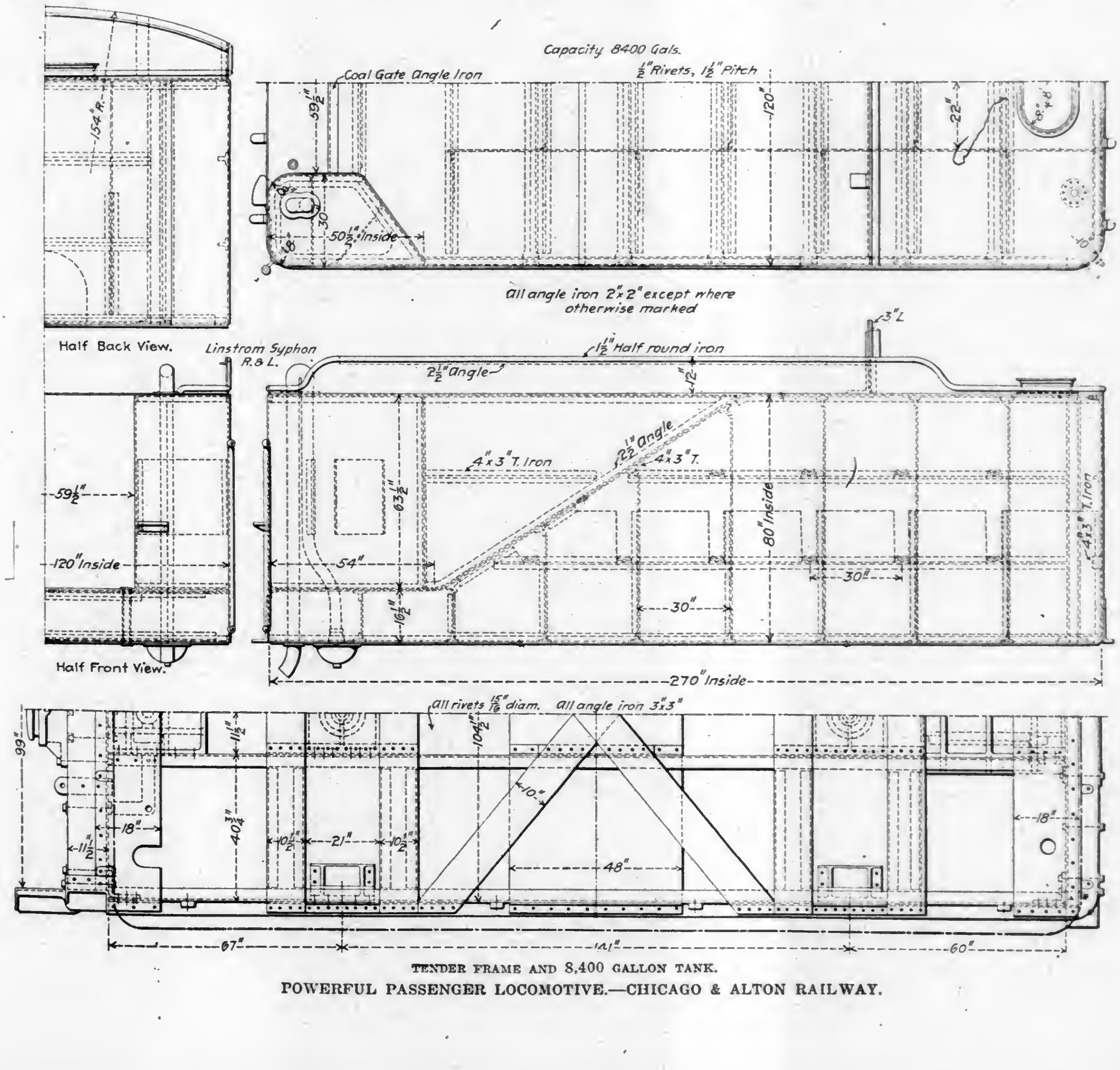
CHICAGO & ALTON RAILWAY.

4—6—2 Type Passenger Locomotive.
General Dimensions.

Gauge	4 ft. 8½ ins.
Cylinder	22 x 28 ins.
Valve	Balanced piston
Boiler—Type	Straight
Diameter	70 ins.
Thickness of sheets	11-16 in., 23-32 in. and ¾ in.
Working pressure	220 lbs.
Fuel	Soft coal
Staying	Crown bar, 5¼-in. x 6-in. T-section
Firebox—Material	Steel
Length	108 ins.
Width	72¼ ins.
Depth	Front, 73⅝ ins.; back, 64⅛ ins.
Thickness of sheets: Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ⅝ in.	
Water space	Front, 4½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes—Material	Iron
Wire gauge	No. 11
Number	328
Diameter	2¼ ins.
Length	20 ft.
Heating surface—Firebox	202 sq. ft.
Tubes	3,848 sq. ft.
Firebrick tubes	28 sq. ft.
Total	4,078 sq. ft.
Grate area	54 sq. ft.
Driving wheels—Diameter outside	73 ins. and 80 ins.
Diameter of center	66 ins. and 73 ins.
Journals	Main, 10 x 12 ins.; others, 9 x 12 ins.
Engine truck wheels (front)	Diameter, 33 ins. on No. 1, 36 ins. on No. 2
Journals	6½ x 13 ins.
Engine truck wheels (back)	Diameter, 42 ins.
Journals	8 x 12 ins.
Wheel base—Driving	13 ft. 9 ins.
Rigid	13 ft. 9 ins.
Total engine	32 ft. 8 ins.
Total engine and tender	62 ft.
Weight—On driving wheels	141,700 lbs.
On truck (front)	36,300 lbs.
On truck (back)	41,500 lbs.
Total engine	219,000 lbs.
Tank—Capacity	Coal, 9 tons; water, 8,400 gals.
Tender—Wheels	Number, 8; diameter, 36 ins.
Journals	5½ x 10 ins.

Mr. C. P. Coleman has resigned as purchasing agent of the Lehigh Valley Railroad, and will engage in business. The duties of his office will be performed by Mr. J. A. Middleton, second vice-president, at his office at 39 Cortlandt street, New York City.

Mr. W. J. Taylor, of the Taylor Iron and Steel Company, died February 17 at his home in Bound Brook, N. J., after an illness of only a few days. He was widely known as one of the pioneers in the manufacture of car-wheels.



TENDER FRAME AND 8,400 GALLON TANK.

POWERFUL PASSENGER LOCOMOTIVE.—CHICAGO & ALTON RAILWAY.

EXTENSIVE SHOP IMPROVEMENTS.

JACKSON, MICHIGAN.

MICHIGAN CENTRAL RAILROAD.

THE POWER PLANT.

One of the most important features of the extensive improvements under way at the locomotive repair shops of the Michigan Central Railroad, at Jackson, Mich., is the introduction of the electrical system of distribution of power, together with the installation of a very complete central power plant, which will not only supply all the lighting and the power for the machine tools, cranes, etc., at the shops, but will furnish current for the electric lighting of the union depot and freight department buildings in the center of the city, about a mile away, and also for the night lighting of the extensive yards located in the eastern section of the city. This power plant, which has recently been completed and placed in service, has replaced four separate isolated power plants of boilers and engines which were scattered around adjoining various shop buildings—the machine shop, the blacksmith shop, the carpenter shop and the roundhouse.

A departure from the more usual method of power distribution is an important feature of this installation, in that the three-phase alternating-current system is used rather than the direct-current system. This was due partly to the desire to supply current for the lighting at the depot buildings, the transmission to which required a rather high voltage on account of the distance—for this the alternating current is particularly applicable as, unlike direct-current, it may be transformed up to the high voltage at the power plant and then transformed back down at the point of consumption, thus confining the dangers of the high voltage to the transmission line only and still deriving the advantages of its high economy in transmission. Another important advantage accompanying this, however, is that due to the extreme simplicity and durability of the induction motor on account of its freedom from brushes or other exposed contacts, there being nothing but short-circuited windings on the rotor or rotating part.

The power plant building is of substantial steel and brick construction, with inside dimensions of 89 ft. north and south, and 85 ft. east and west. The south 50 ft. of the building is devoted to the boiler room, and the north 38 ft. and 11 in. to the engine room, a 13-in. brick wall dividing the two rooms. The height from the floor of the boiler room to the bottom chord of the roof trusses is 24 ft., and the height to the top inside of the monitor over the boiler room, 43 ft.; the height from the engine room floor to the roof trusses is 22 ft. The walls are brick on concrete foundations, the roof being expanded metal and cinder concrete carried on steel roof trusses. The monitor is also of steel construction, with expanded metal and concrete roofing. The engine room is ventilated by 6 large Pancoast ventilators.

The floors in both the engine and boiler room are built of cinder concrete with cement dressing, in all 6 ins. thick, the engine room floor level being 2 ft. above that of the boiler room and not excavated. Brick pilasters support the roof trusses and also the crane runway in the engine room; the crane has a span of 37 ft. 2 ins., and is of 7½ tons capacity, operated by hand power. A concrete lined tunnel, 6 ft. in the clear inside height and 4 ft. 6 ins. wide outside of pilasters, extends the entire length of the engine room adjoining the division wall; the roof of this tunnel is expanded metal and concrete supported on 5-in. I-beams. A further tunnel extends from this cross tunnel on the line G-D, shown in the accompanying floor plan, to a point in front of the air pumps, this tunnel being covered by checkered steel plates.

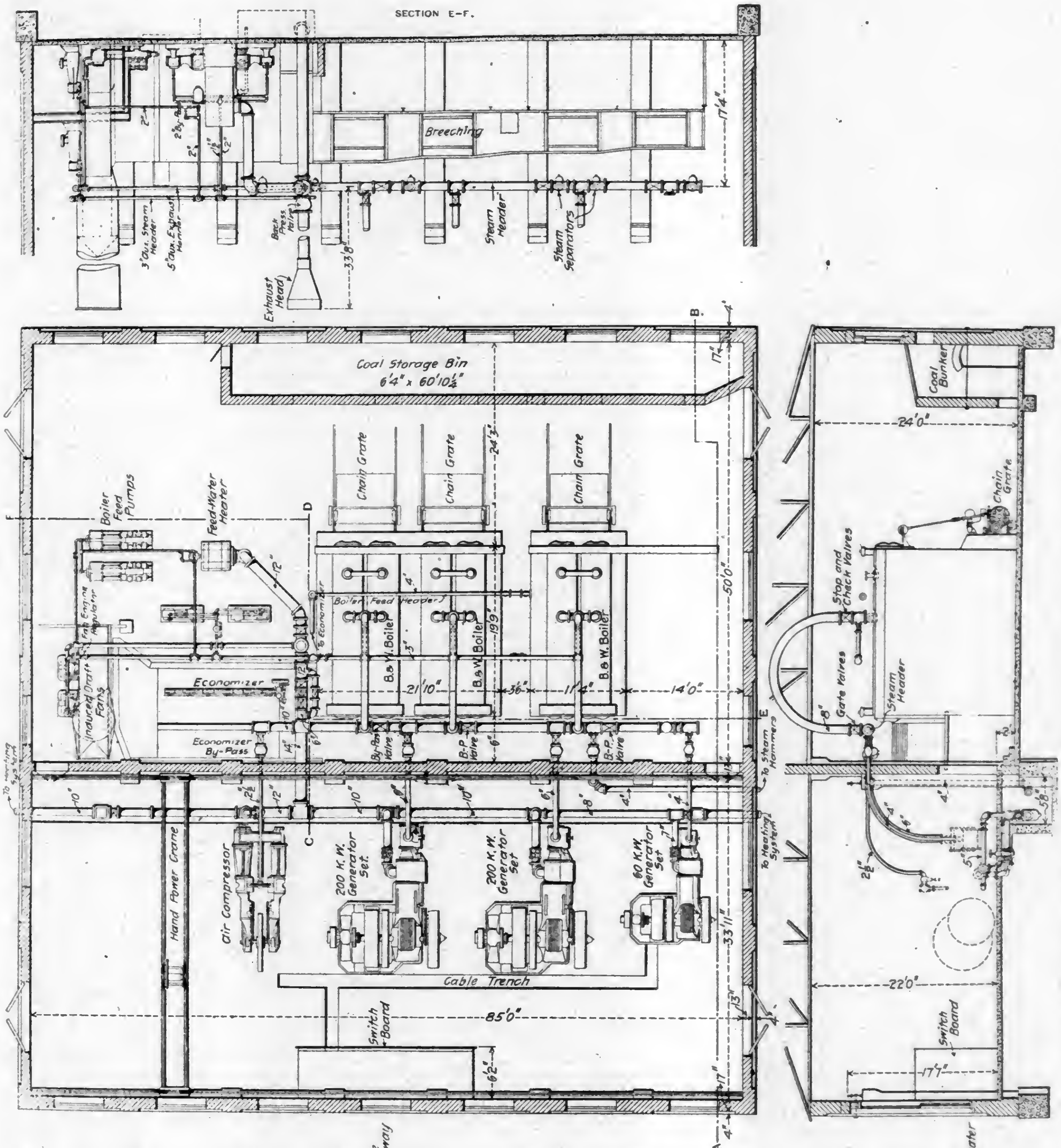
The boiler equipment consists of three Babcock & Wilcox water-tube boilers of their vertical header type, each boiler having 2,640 sq. ft. of heating surface and rated at 264 h.-p. They are set in batteries of two, one battery having at present, however, only a single boiler, provision being made for the addition of a fourth boiler to complete that battery at some future time. A view of the boilers is presented on page 93, which engraving also shows the Green stokers.

All three of the boilers are equipped with automatic stokers of the link grate type made by the Green Engineering Co., of Chicago, Ill. Each stoker has a free width of grate over the traveling links of 7½ ft. and the effective grate area is 67½ sq. ft. presented between the front housings and the arch. The traveling link portion of the grate is driven, at a very slow rate, by power from a shaft above, through an eccentric and ratchet mechanism, the shaft being driven by a small vertical engine on top of the coal bunkers; an engine was here preferred to a motor to permit starting before dynamos are running. The framing of the stokers' mechanism is very substantial, and a smoke arch of novel design is used, having the supporting framework far removed from the heat of the fire. The stokers are arranged for hand feeding from the floor, the coal being stored in the large bunker shown at the south side of the boiler room—see floor plan on page 89. The coal is shoveled direct into these bunkers from the cars on a slightly elevated track outside the building, and is drawn out for firing through feeding holes at the floor on the boiler-room side.

Particular attention is called to the automatic self-cleaning feature of the traveling link grate. The fuel is fed onto the grate at the front and is slowly carried toward the rear, during which it burns progressively; the speed of travel is so adjusted that the fuel is completely burned as it is dumped off the grate at the rear. This feature of dumping as the links pass over the rear drum of the carrier mechanism causes the grates to be self-cleaning and absolutely prevents any clogging or trouble from clinkers. When properly installed and handled these grates consume the fuel practically smokelessly. Thus, while of considerable greater first cost than ordinary grates, they will burn fuel smokelessly and economically, and are operated much more economically than plain grates.

The waste fuel gases are carried from the boiler to the economizer through a wrought steel breeching, built up of ⅛-in. steel plate with angle-iron stiffeners. The economizer, which has a capacity sufficient for four boilers of the size installed, has 192 vertical tubes, presenting a total of 2,400 sq. ft. of heating surface for heating the feed-water from the waste gases; it was installed by the Green Fuel Economizer Company, Matteawan, N. Y. A by-pass is arranged around the economizer which may lead the waste gases from the breeching direct to the induced draft fans, if it is desired for any reason to cut the economizer out of use. The gases are deflected into either path by a swing damper of novel construction mounted upon roller bearings placed outside of the smoke-flue and which therefore will not deteriorate through the action of the hot gases and thus will always swing easily. At the outlet end of the economizer there is arranged a louvre damper, which may be closed when the economizer is shut down for repairs in order to keep it free from the gases. Details of the economizer and the by-pass damper are shown in the drawings on page 91.

The induced draft apparatus, which is located in the northeast corner of the boiler room, consists of two 7-ft. blast fans operated by direct-connected vertical steam engines, together with the steel stack and connections, all of which were furnished by the B. F. Sturtevant Company, Boston, Mass. The fans are arranged one above the other for economy of space, as shown in the elevation drawings of the boiler room, the upper fan and its engine being supported upon a steel platform of I-beams 9 ft. 4 ins. above the floor. Each fan is driven by a single engine, with cylinder 8 ins. in diameter by 6-in. stroke, of the well-known vertical inclosed type of the



FLOOR PLAN OF POWER PLANT AND ELEVATION VIEWS OF THE ENGINE AND BOILER ROOMS.

JACKSON SHOPS POWER PLANT.—MICHIGAN CENTRAL RAILROAD.

E. D. BRONNER, *Superintendent of Motive Power.*

C. H. WILMERDING, *Consulting Engineer.*

Sturtevant Company's make, the blast wheel of the fan being mounted directly upon an extension of the engine's shaft. The blast wheels are each 84 ins. in diameter with 42 ins. face, each fan having a delivery outlet 42 x 48½ ins. in section. Each fan is provided with tight-shutting louvre dampers at the inlet side for cutting it out of service, and the bearings for the engine and fan shaft are all removed from contact with the hot gases and are water-cooled besides to prevent interruptions of service by overheating. Either fan is capable of carrying the load for all of the boilers, the extra fan being installed for reserve to permit shutting one down for repairs at any time. The steel stack is 60 ins. in diameter inside and extends to a height only 48 ft. 5 ins. above the boiler-room floor. This elimination of the high stack, otherwise necessary, with its attendant high first cost and expense of maintenance, is an even greater advantage of the induced draft system than that offered by its remarkable ability to force the boilers to meet sudden and unexpected demands.

The arrangement of the steam piping is shown in the cross-section view of the power plant. The main steam header is supported back of the boilers and over the breeching upon a specially designed pipe gallery and is 10 ins. in diameter throughout its length. The steam is taken from the boilers through Davis automatic stop and check valves, which will close in case of accident to the boiler or piping, and through an 8-in. pipe bend to a gate valve located on top of the header. The connections to the engines are provided with gate valves at the point where they leave the header, next to which are placed steam separators. The pipes then are carried on a bend of 90 deg. to the engine throttles. An auxiliary steam header 3 ins. in diameter is connected immediately above the stop and check valves through gate valves from each boiler. This auxiliary header is used for the supply of steam to the boiler feed pumps, to the induced-draft engines, the engines for operating the stokers, and to the automatic pumps used in connection with the heating system. Also a 4-in. pipe line is run from the main header to the blacksmith shop to supply the steam hammers.

The main exhaust header is carried in the tunnel under the south side of the engine room and receives exhaust from the engines underground. A 14-in. connection is made through the tunnel leading into the boiler room from the main exhaust header to the open feed-water heater and to a riser extending up through the roof and provided with a back-pressure valve and an exhaust head for free exhaust. The back-pressure valve, located in the exhaust riser just above the heater connection, is a Kieley valve, which will open in case the heating system cannot take care of all the exhaust steam, causing a pressure to back up toward the engines. The exhaust from the auxiliaries is also brought in to the main steam pipe below this back-pressure valve. A cross-connection is made from the steam header to this vertical riser through a pressure-reducing valve, which enables live steam to be furnished to the exhaust system for heating in case of necessity.

The piping is of standard wrought-iron pipe, the high-pressure lines being equipped with extra heavy fittings. The valves throughout are of Chapman make, except the pressure-reducing valve and the back-pressure valve, which are Kieley valves, and the automatic stop and check valve and the fan regulator valve on the steam connection to the fan engines, which are of G. M. Davis Regulating Company's manufacture. For the automatic return of the condensed water accumulating in the high-pressure steam pipe, the separator receivers, and at the engine throttles, the Holly system is used. All piping is covered with the H. W. Johns-Manville Company's asbestos sponge-felted covering.

The fan-regulator valve controlling the fan engines is an interesting feature of the boiler equipment. It is inserted in the steampipe leading to the fan engines and set for the desired pressure to be carried on the boilers. Normally the valve is open until the pressure rises and overcomes the weighting, when it slowly closes and slows down the engine driving the fan. When the pressure drops the valve opens and allows the engine to speed up again, thus automatically keeping the boiler pressure at as near a fixed point as the regulation of induced draft will accomplish. The regulator is provided with an adjustment arrangement so that the valve throw may be limited and the maximum and minimum speed of the engine may be fixed. It is found best to adjust the throw of the valve not to shut off entirely, so as to keep the engine moving and thereby avoid dead centers.

The boilers are fed by two Worthington 7½ x 4½ x 10-in. outside-packed pressure-pattern feed-pumps, which draw water from a Webster vacuum heater of 1,200 rated horse-power capacity.

HEATING SYSTEM.

The main exhaust header in the engine-room tunnel extends the full length of the building and out underground at each end through a Webster oil separator. These pipes form the mains for the heating system throughout the entire plant. The return pipes are brought in through this tunnel at each end and are carried into the boiler room to the two vacuum pumps. The shops had formerly been heated by live steam direct from boilers, while all exhaust steam had been allowed to escape to the atmosphere. In the new plant, with the installation of new engines of much greater capacity than formerly used, the exhaust steam from them, together with that from the hammers in the blacksmith shop, was considered too valuable to throw away. After looking into the merits of the various methods and systems of heating and circulating steam, the Webster system was adopted and is now in successful operation.

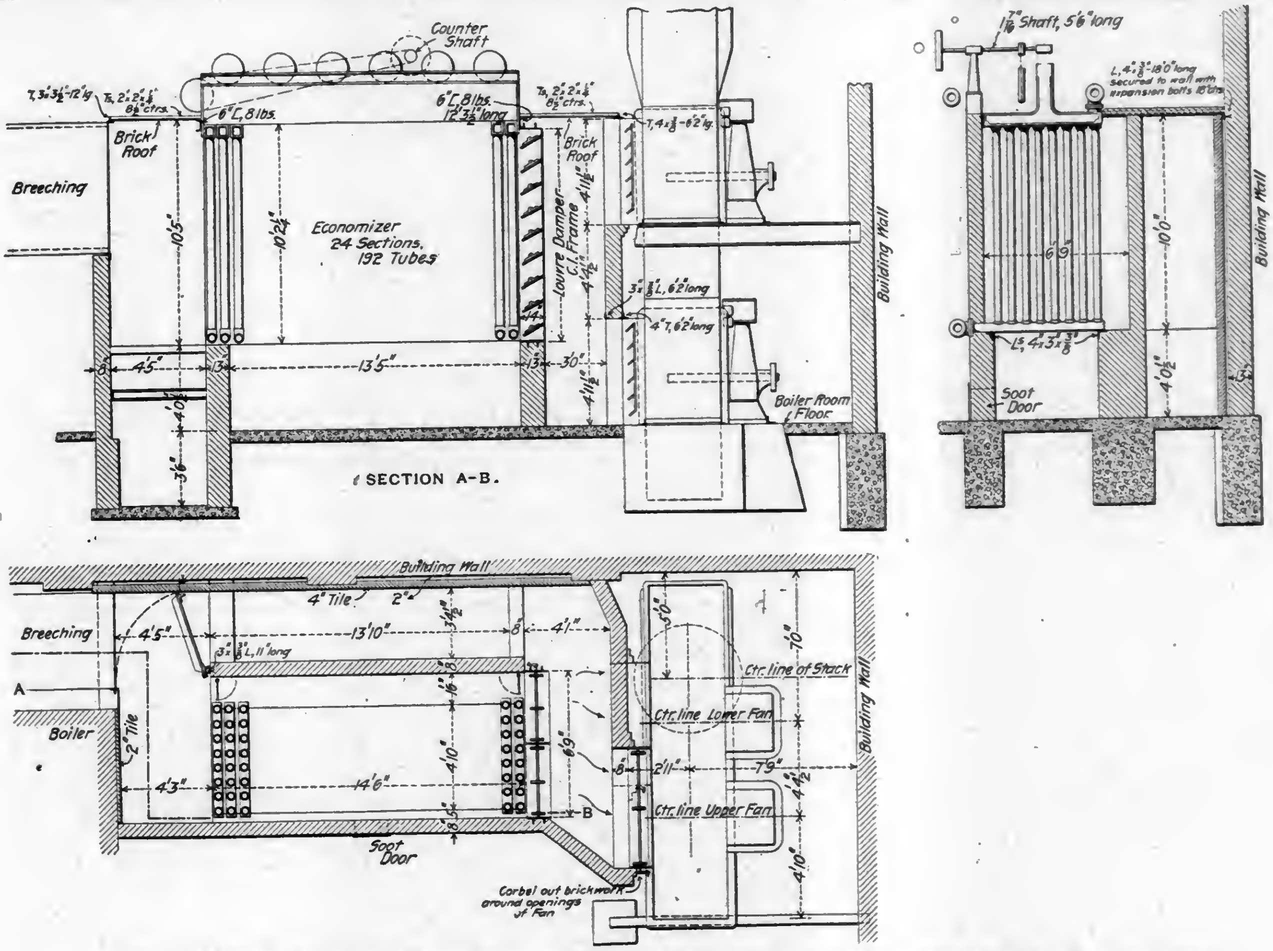
The locomotive and machine shops, which are both under one roof, contain in all 3,300,000 cu. ft. of air, and for heating there has been installed two fans and large groups of blast coils, containing in all 21,000 lineal feet of 1-in. pipe. These fans and coils are of the National Blower Company's manufacture. The other buildings in the group are heated by direct radiation in the form of wall or ceiling coils and cast-iron radiators, there being, all told, about 15,000 sq. ft. of direct heating surface with a cubical contents of buildings of about 2,000,000 cu. ft.

The supply piping is run from the power house to the nearest buildings, and between buildings, through tunnels and trenches; but is raised and suspended overhead inside the buildings. The system of return piping is all run in trenches under the ground or floors, and connections are made to these returns from every heating unit.

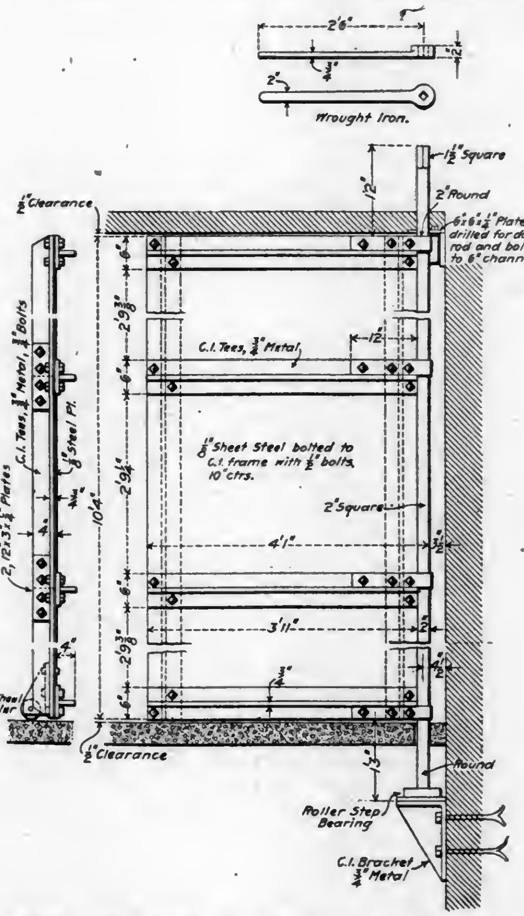
Two special vacuum pumps in the boiler room are connected to the main returns and are used to draw the water of condensation and air from the coils and radiators, the condensation being delivered into a Webster feed-water heater and purifier. The extraction of air and water from each radiator and coil is controlled by special Webster thermostatic water and air relief valves, attached to the return end of the unit in place of the ordinary air valves.

By the use of the Webster system, exhaust steam is used to the fullest extent, and when not sufficient is supplemented by live steam from the boilers under a reduced pressure. The circulation is accomplished under a pressure below that of the atmosphere, all air and water being extracted, the former escaping to the atmosphere and the latter entering the feed-water heater to be used again for boiler-feed purposes.

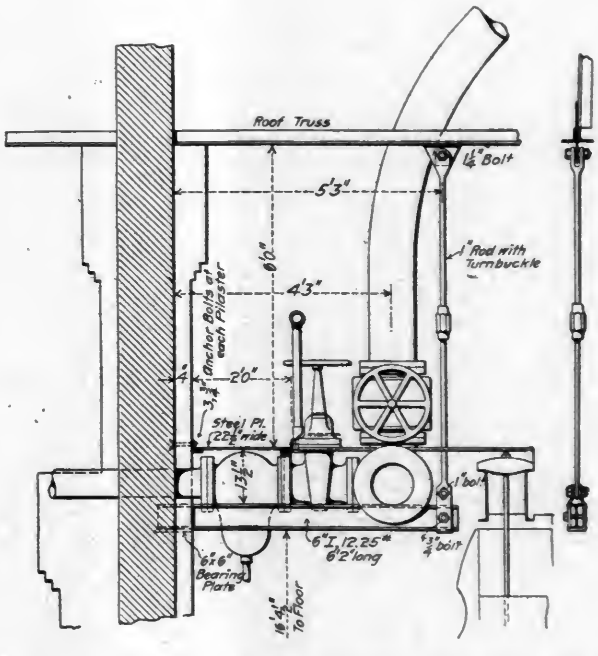
The heating plant was installed, under the supervision of Charles H. Wilmerding, consulting engineer, by Thomas & Smith, the heating contractors. The Webster system was installed under the supervision of the American Engineering Specialty Company, Chicago, Ill., Western agents of Warren Webster & Company.



SECTIONAL DRAWINGS AND PLAN OF ECONOMIZER, SHOWING CONNECTIONS BY LOUVRE DAMPERS WITH THE EXHAUST FANS.

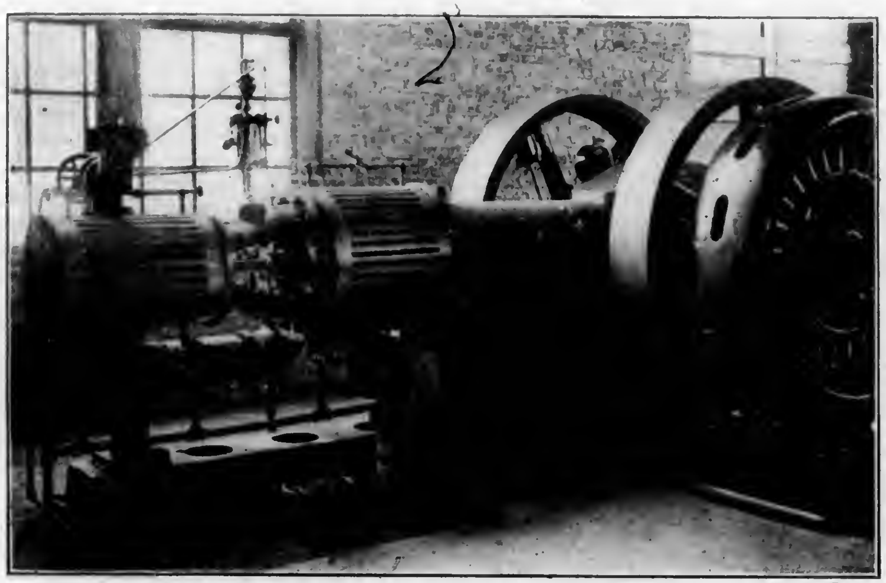


DETAILS OF BY-PASS DAMPER IN BREECHING AT ENTRANCE TO THE ECONOMIZER, SHOWING ARRANGEMENT OF ROLLER BEARING.

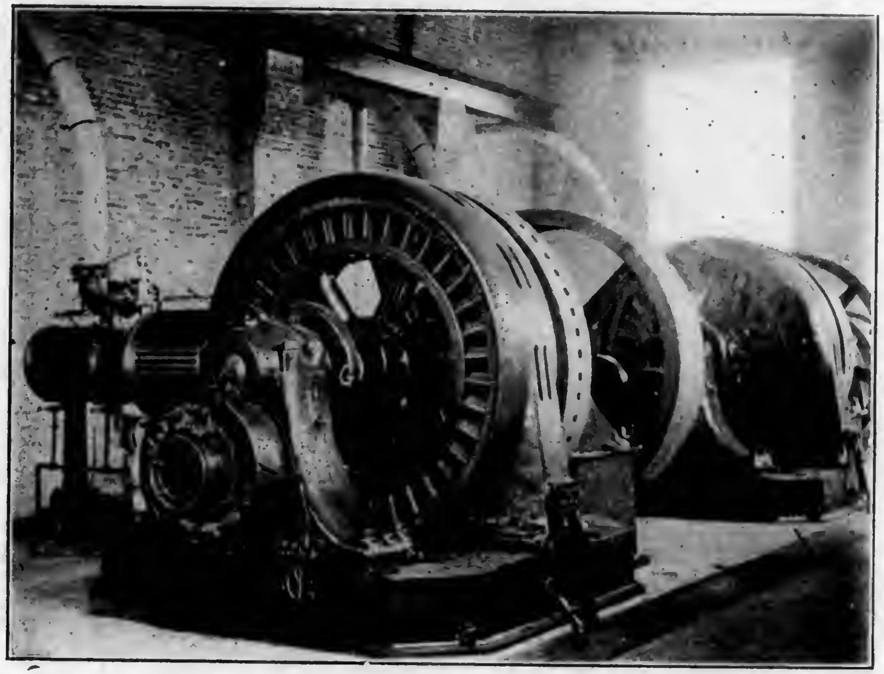


DETAIL OF PIPE GALLERY AT REAR OF BOILERS, SUPPORTING THE MAIN STEAM HEADER AND GIVING ACCESS TO ALL STEAM VALVES.

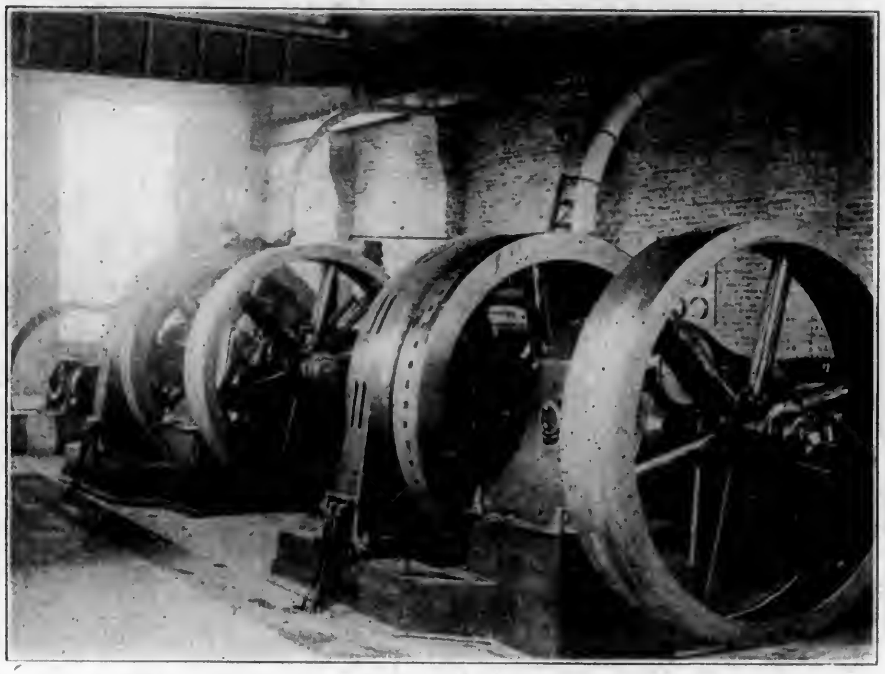
EXTERIOR VIEW OF POWER HOUSE—EAST END. SHOWING ARRANGEMENT OF OPENINGS INTO COAL BUNKERS ALONGSIDE OF ELEVATED TRACK.



THE 10 X 16 X 14 TANDEM COMPOUND BALL ENGINE, WHICH DRIVES THE 60-KW. STATIONARY ARMATURE GENERAL ELECTRIC GENERATOR.



VIEW OF THE 200-KW. THREE PHASE GENERAL ELECTRIC ALTERNATOR, SHOWING METHOD OF DRIVING EXCITER THROUGH GEARING FROM GENERATOR SHAFT AT G.



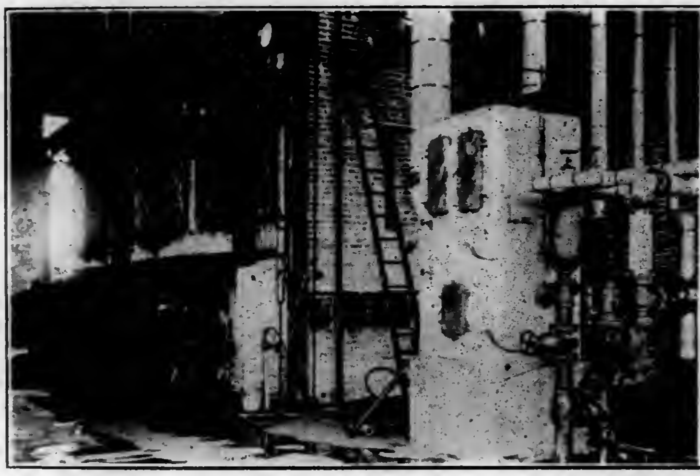
GENERAL VIEW OF ENGINE ROOM SHOWING ARRANGEMENT OF ENGINE AND DYNAMOS, AND THE 7½ TON HAND CRANE.

JACKSON SHOPS POWER PLANT.—MICHIGAN CENTRAL RAILROAD.

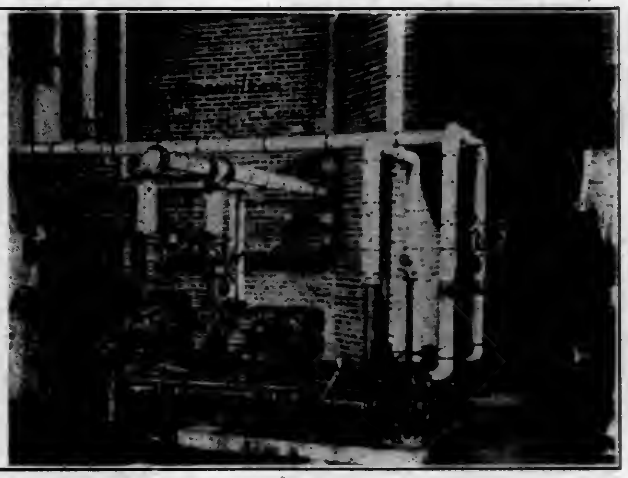
GENERAL ELECTRIC EIGHT-PANEL SWITCHBOARD, SHOWING WATTMETERS UPON THE TWO MIDDLE PANELS.

200-kw. machines, while that driven by the smaller engine is a 26-pole 60-kw. machine. A particular feature of these dynamos is the method of operating the compensating exciters by mounting upon the outboard bearing pedestal and gearing direct from the main shaft. The rating of these dynamos is on the basis of an increase in temperature not to exceed 25 deg. C. after a continuous full-load run of 24 hours.

The cables leading from the generators to the switchboard are carried in a checkered-plate covered trench in the floor, as shown in the generator view on page 92, which leads to a pit behind the board. The switchboard, which was built by the General Electric Company, consists of eight panels of blue Vermont marble, 90 ins. high by 32 ins. wide by 2 ins. thick, mounted on an angle-iron platform and braced out from the wall at a distance of 6 ft. Three of the panels are generator panels, two are lighting panels and the other three are power-feed panels. The board is equipped with two recording wattmeters, one for registering the power output and the other the lighting output. There are at the rear two sets of bus bars, one set for power and one for lighting. The power feeder panels are equipped with automatic oil switches. The cables from the generators are brought in under the switchboard to a pit 4 ft. 3 ins. deep, which is covered over at the floor level with a wooden grating supported on steel I-beams. All outgoing feeders are taken out from the bottom of the board into the pit and led out in lead-covered cables underground.



VIEW OF THE BOILERS, SHOWING TRAVELING LINK GRATES, FEED-WATER HEATER AND PUMP GOVERNOR.



VIEW OF BOILER FEED PUMPS, SHOWING ALSO ECONOMIZER AND INDUCED-DRAFT FANS IN PART.

JACKSON SHOPS POWER PLANT.—MICHIGAN CENTRAL RAILROAD.

The engine equipment consists of two tandem-compound horizontal engines, with cylinders 16 and 25 ins. in diameter by 18 ins. stroke, which run at 200 revolutions per minute, and a smaller tandem-compound engine, with cylinders 10 and 16 ins. in diameter by 14 ins. stroke, all three of which were furnished by the Ball Engine Company. They are all of the shaft-governor automatic cut-off type, and operate non-condensing at an initial steam pressure of 150 lbs. per square inch. They are all provided with synchronizing devices, by which they may all be brought to a common speed when the dynamos are being operated in parallel.

An old air-compressor moved from one of the previous power plants is installed in the engine room for present purposes. It is a Rand two-stage compressor, with inter-cooler, having 10 x 16-in. steam cylinders and 7½ and 14 x 16-in. air cylinders, delivering at a pressure of 120 lbs. The dimensions of the engine room, however, are such as to admit of the installation later of an air-compressor of 1,000 or 1,200 cu. ft. capacity, and also anadditional 200-kw. generating unit.

Each of the engines are direct-connected to an alternating-current three-phase, 60-cycle, compensating exciter type generator, with stationary armature and wound for 480 volts, all of which were built by the General Electric Company. The generators driven by the two larger engines are both 36-pole

The present electrical load to be operated from this plant consists of 480 h.p. in motors driving machine tools, etc., 107 arc lamps and about 600 incandescent lamps, besides three alternating current cranes, two of 60 tons each with auxiliary 10-ton hoists, and one crane of 7½ tons capacity. The first two cranes are equipped with 45-h.p. motors for the main hoist and for the bridge travel, 30-h.p. motors for auxiliary hoist and 10-h.p. motors for trolley travel, while the 7½-ton crane is equipped with 11-h.p. motors for the main hoist and the bridge travel and a 3-h.p. motor for the trolley travel. The total connected load in motors, therefore, will be 743 h.p.

We are indebted to Mr. C. H. Wilmerding, consulting engineer, for drawings, information and assistance in the preparation of this description. Mr. Wilmerding designed the building and superintended its construction.

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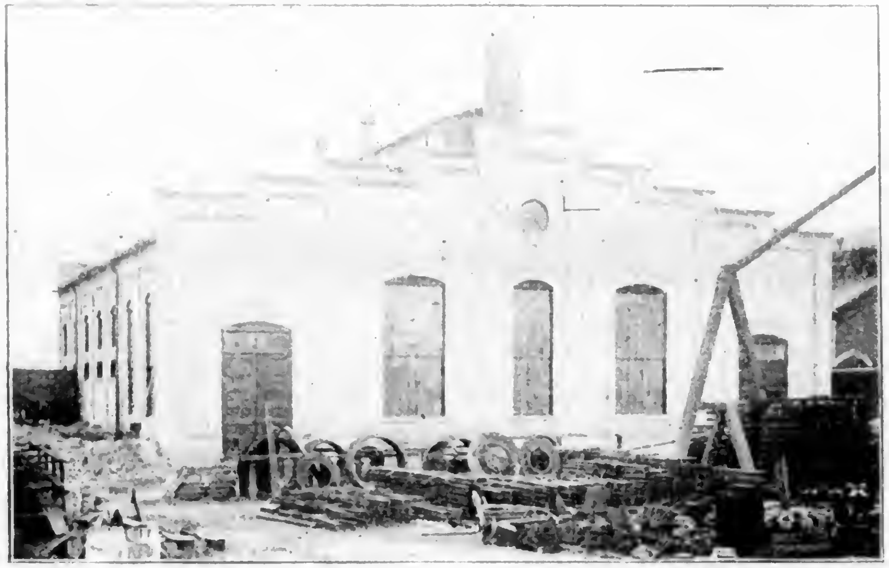

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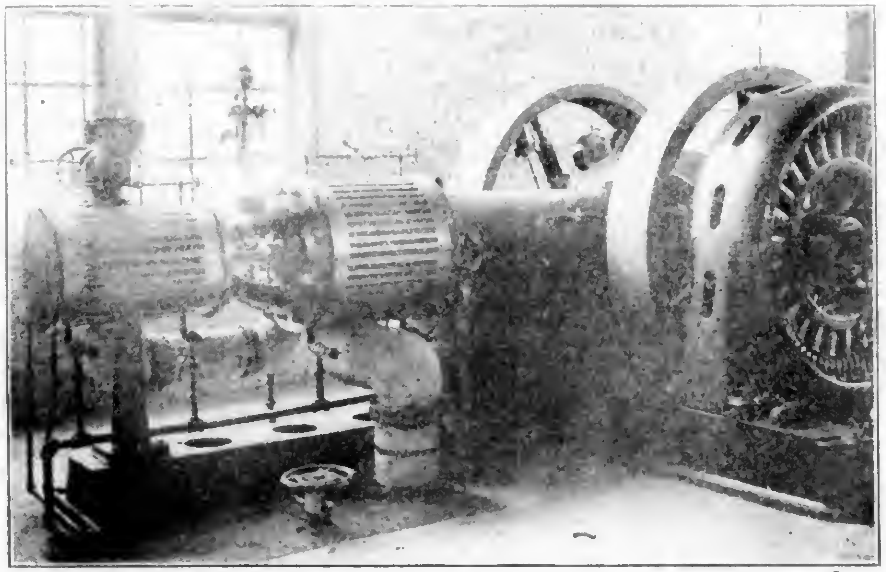

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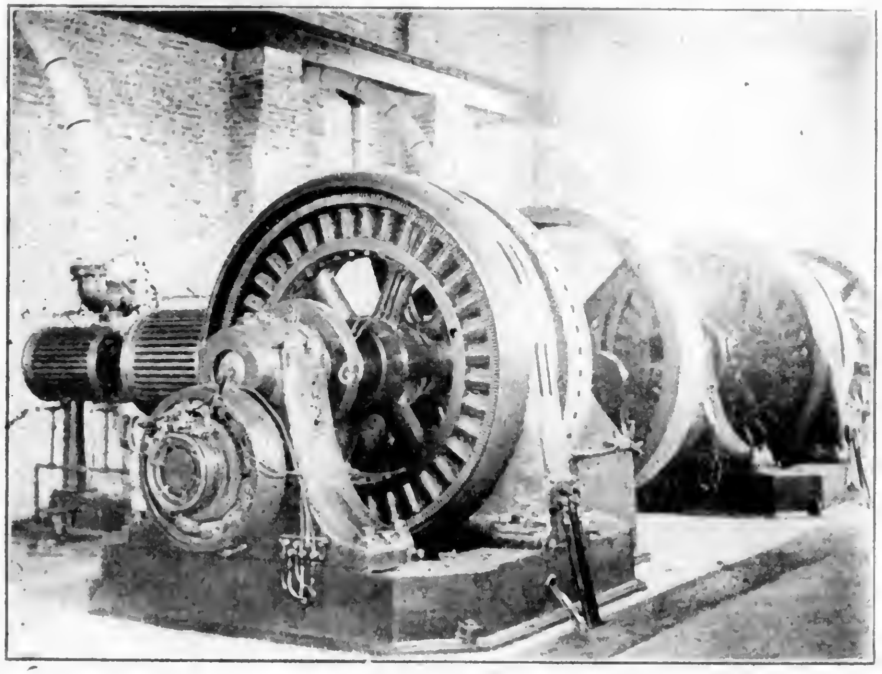

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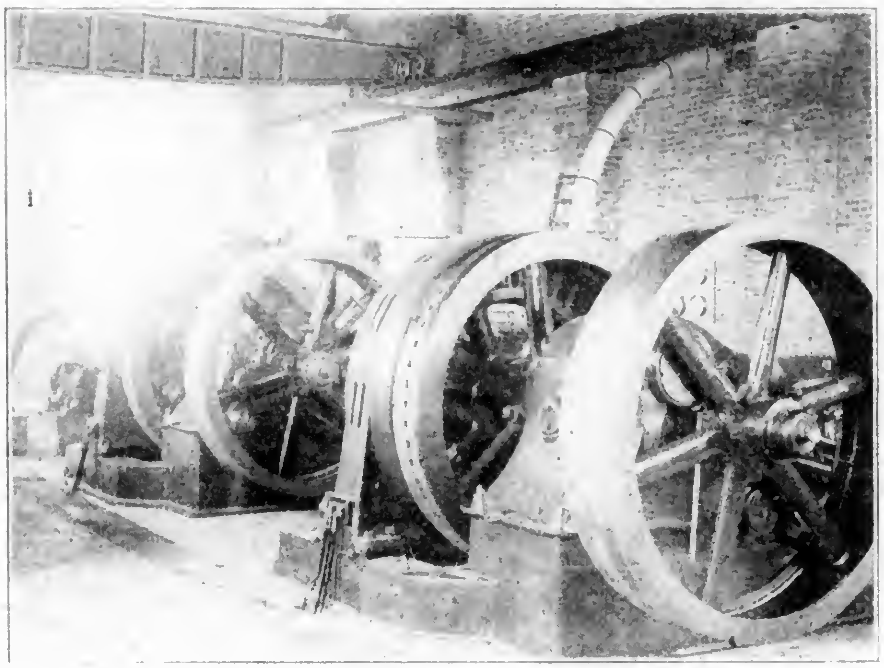

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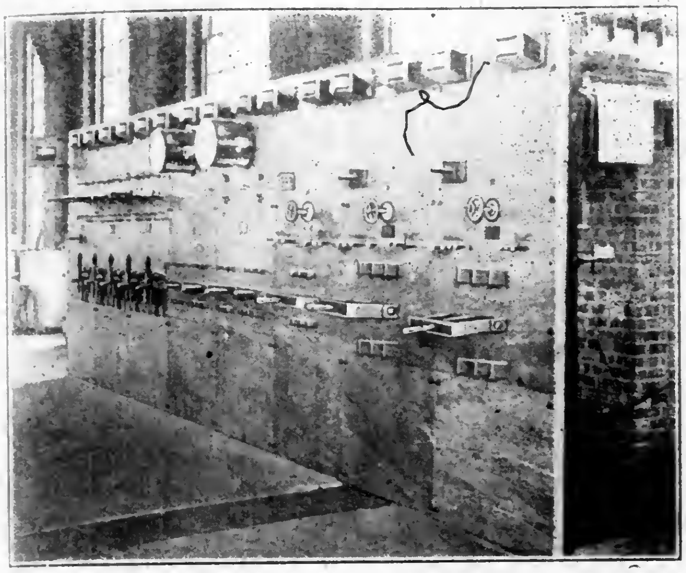

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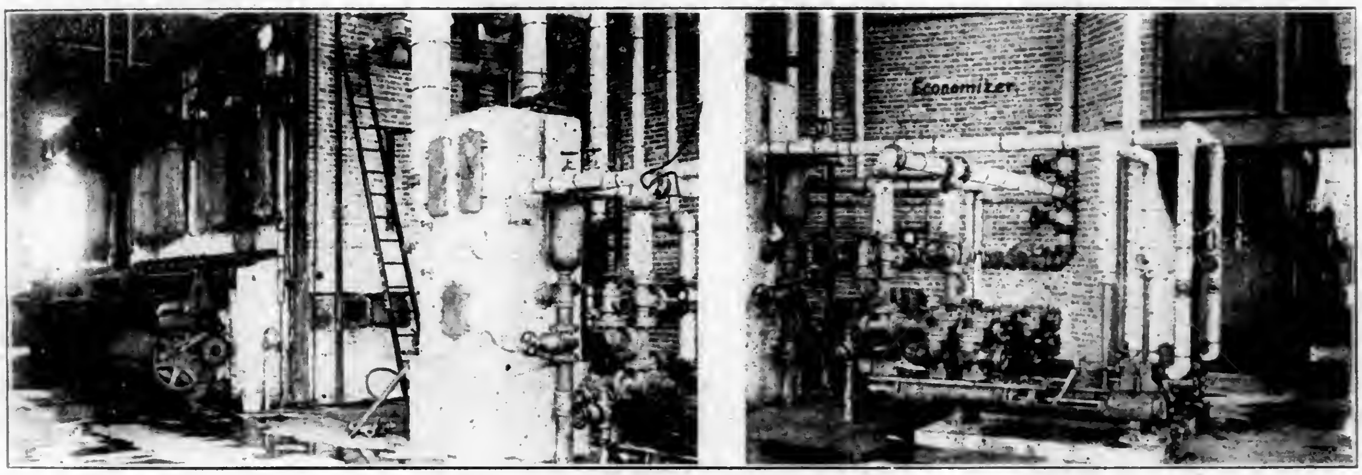

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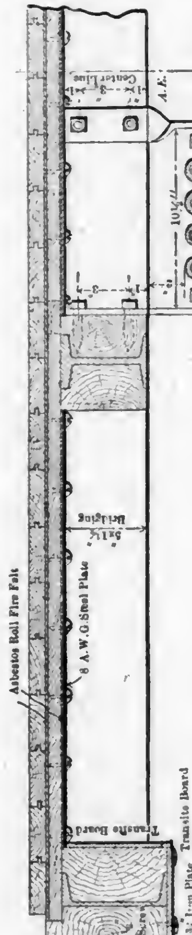
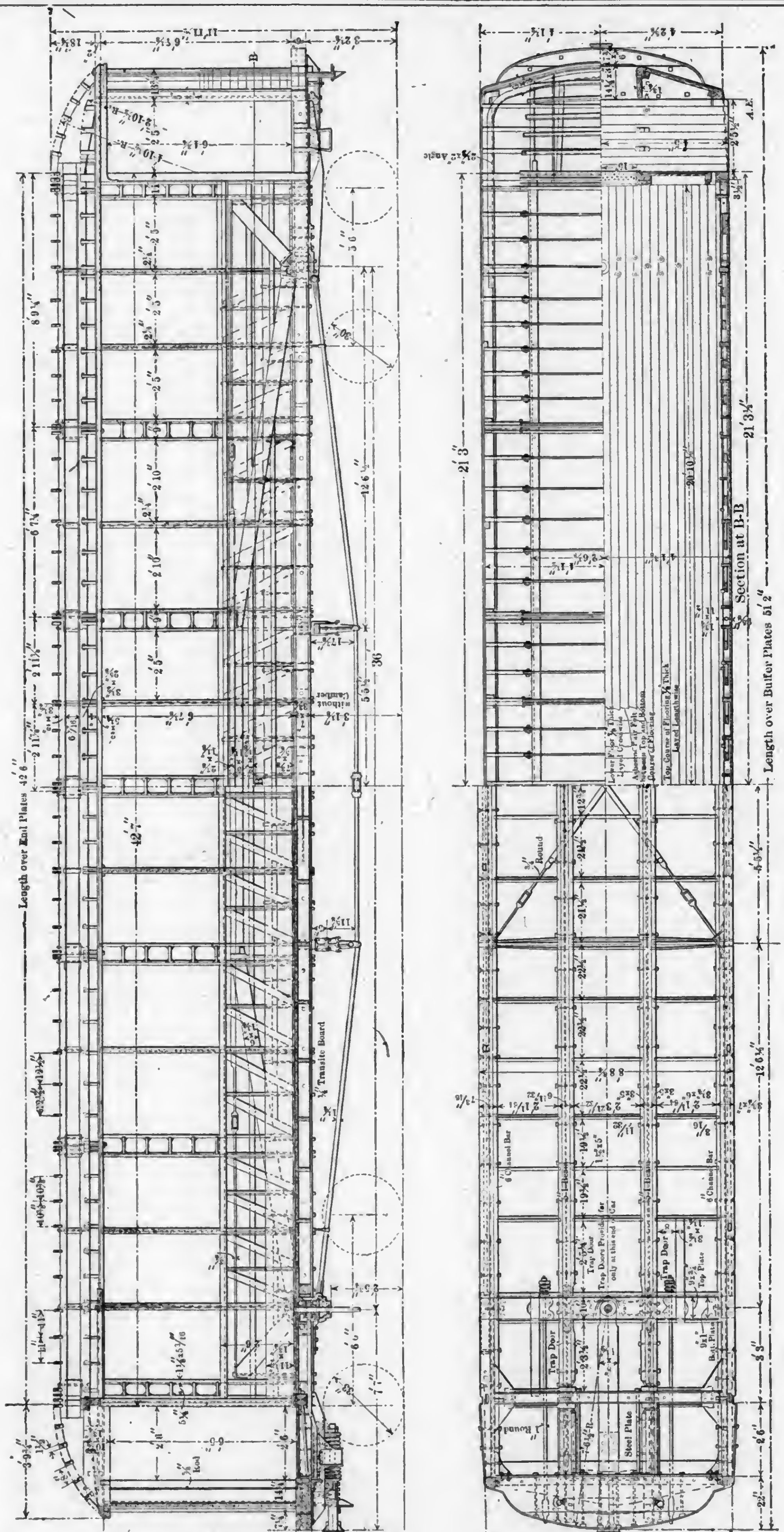
SEATING PLAN.



PARTIAL SECTION OF FLOOR, SHOWING "TRANSITE BOARD" SHEATHING.



FLOOR AND SIDE FRAMING.

PASSENGER CARS—INTERBOROUGH RAPID TRANSIT COMPANY, NEW YORK CITY.

NEW YORK SUBWAY CARS.

INTERBOROUGH RAPID TRANSIT COMPANY.

FRAMING AND CONSTRUCTION DETAILS.

Photographic views of the sample cars built for this road were illustrated on page 308 of this journal for October, 1902. Since that time the standard construction has been determined upon, and 500 cars are now being built, to be ready for service when the road opens next year. The details were worked out under the direction of Mr. George Gibbs, consulting engineer of the road.

General Dimensions.

	Ft.	Ins.
Length over body corner posts	42	7
Length over buffers	51	2
Length over drawbars	51	5
Center to center, needle beams	10	11
Width over side sills	8	8¾
Width over sheathing	8	10
Width of platforms	8	10
Width over eaves	8	6
Height, top of rail to under face of side sill at truck (car light)	3	1⅛
Height, top of rail to top of roof at center (car light)	12	¾
Truck centers	36	0
Diameter of motor truck wheels		33
Diameter of trailer truck wheels		30
Weight of car body (estimately)	27,000 lbs.	

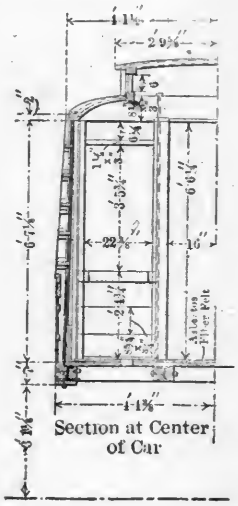
Steel Shapes in Frame.

Side sills	6-in., 8-lb. channels, 47 ft. 4¾ ins. long
Body end sills	5-in., 11½-lb. channels, 8 ft. 1¼ ins. long
Drawbar supports	4-in., 6¼-lb. channels, 3 ft. 4½ ins. long
Center sills	5-in., 12¼-lb. I-beams, 47 ft. 4¾ ins. long
Needle beams	5-in., 9¾-lb. I-beams, 8 ft. 6 ins. long
Platform supports	5-in., 16-lb. Z-beams, 4 ft. 6 ins. long
End bars in hood	2½ by 2 by ⅜-in. angles
Platform end sills	5 by 4 by ⅝-in. angles
Sector bars	6 by 3½ by ½-in. angles
Platform supports	6 by 4 by ½-in. angles

The bodies are the same for motor and trailer cars. The motor cars have one motor and one trailer truck. The difference in height due to the difference in the wheel diameters is made up in the truck design.

PLATFORMS.

The channels and beams in the longitudinal sills are secured to steel angles forming the platform end sills, to which are



Section at Center of Car

also attached the anti-telescoping plates and anti-telescoping posts. The latter extend and are secured to the steel angles forming the end bow reinforcements, which are secured to the end bows, with ends extending along the sides of the side plates in the car body and are secured thereto. The platform structure at each end is supported by Z-bars and angles, the Z-bars being bolted to the center sills and the angles to the side sills. These supports extend beyond the platform end-sill angles to support the platform sills and buffer beams. Two rods at each end of the car with threaded ends pass through the end-sill angles and end-wall castings for the platform trussing. The buffer beam is built up of white oak, and is secured to two oak timbers placed on the Z-bar supports and bolted to the bars and end-sill angle. A cast-steel drawbar carrier is bolted under the end-sill angle between the Z-bars. On each Z-bar is a sector bar support to which the steel angle sector bar faced with plate steel is bolted. On each side of the platform, resting in castings under the buffer beams and extending through the body bolster, is a safety chain anchor rod, with a spring seating against the body bolster filling casting.

FRAMING.

The side sills are of heavy steel channels, the center sills of heavy I-beams; all longitudinal sills are reinforced on the sides with heavy timbers, as shown in transverse section. The body end sills are channels secured to the side sills by gusset plates and to the center sills by steel castings. The body bolsters are of plates, with a steel draw casting at the center. Under the body end sills are cross trusses, and other cross trusses are provided at the needle beams. Special attention was given to securing strong construction in the floor and roof framing at the ends of the car. The body counterbrace rests at the ends in pocket castings over the bolsters, and brace-rods are secured to the long brace at the joints, passing through the side sills at the needle beams. On each side of the car is a long truss rod with flat ends hooked over the short diagonal braces at the ends of the car. These rods have turnbuckles and extend from end to end of the car. Toward the center of the car the rod is a flat bar, gained into the posts. The ends of the short diagonal braces at the ends of the body counter brace are bored for rods, passing down through the side sills near the bolsters. The truss plank is of Southern pine 1¾ x 11½ ins., extending the full length of the car to the body corner posts in one piece. At the center of the car is a pair of diagonal brace rods secured to the side slils. The spaces in the bracing below the windows are filled with whitewood blocking.

ROOF FRAMING.

The engravings are intended to illustrate the roof and vestibule construction without detailed description. The principal carlines, of which there are seven, are composite, of wrought iron shaped to the roof and sandwiched between two white ash carlines. White ash is used for the side deck intermediate, upper deck and hood carlines.

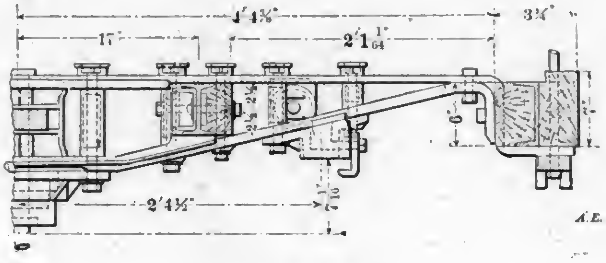
The cars are fitted with guard chains, hand holds and safety gates, everything being designed with a view of allowing the cars to pass the 90-ft. radius curves on the Manhattan tracks, in case the cars should be used on the elevated roads. For this purpose auxiliary bolsters were provided at each end of the cars and extension links are used for transmitting the draw bar pull to the bolsters.

To guard against fire from the wiring the floors are ceiled underneath with ¼-in. "Transite" board secured to all the bridging. The cables are also protected by conduits of the same material, and no wires enter the cars except for lighting and heating. Over the motors the protection is reinforced by steel plate and fire felt. All of these cars have the Gibbs sliding door in the vestibules. The floor is grooved. The cars are sheathed with copper outside and are finished inside with mahogany of light color. The headlining is of composite board.

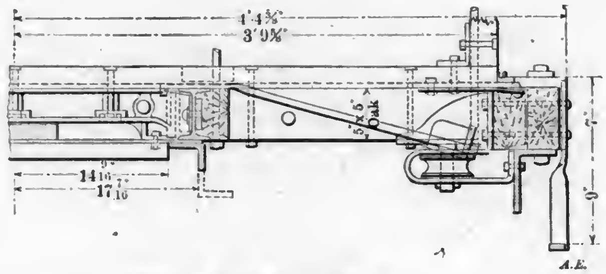
The cars will seat 52 persons. The spaces under longitudinal and cross seats are ceiled up with framework of wood, in which the electric heaters are placed. The interior finish is rather plain, but neat; the panels have marqueterie linings, and all mouldings are plain. The ceiling is of half Empire design, painted light color, with plain decoration. The cars will be lighted with incandescent electric lights, 26 of which are placed on the ceilings inside of the car and two above each platform in the hood. The platform doors are of exceedingly

novel design; the side or exit doors are operated by levers from the end of the car, and the end door is so arranged that when the platform is used as the motorman's compartment this door closes the passageway between the center vestibule-posts, giving the motorman the freedom of the entire platform, and when the door is folded back into the open position it encloses the master control and motorman's brake-valve.

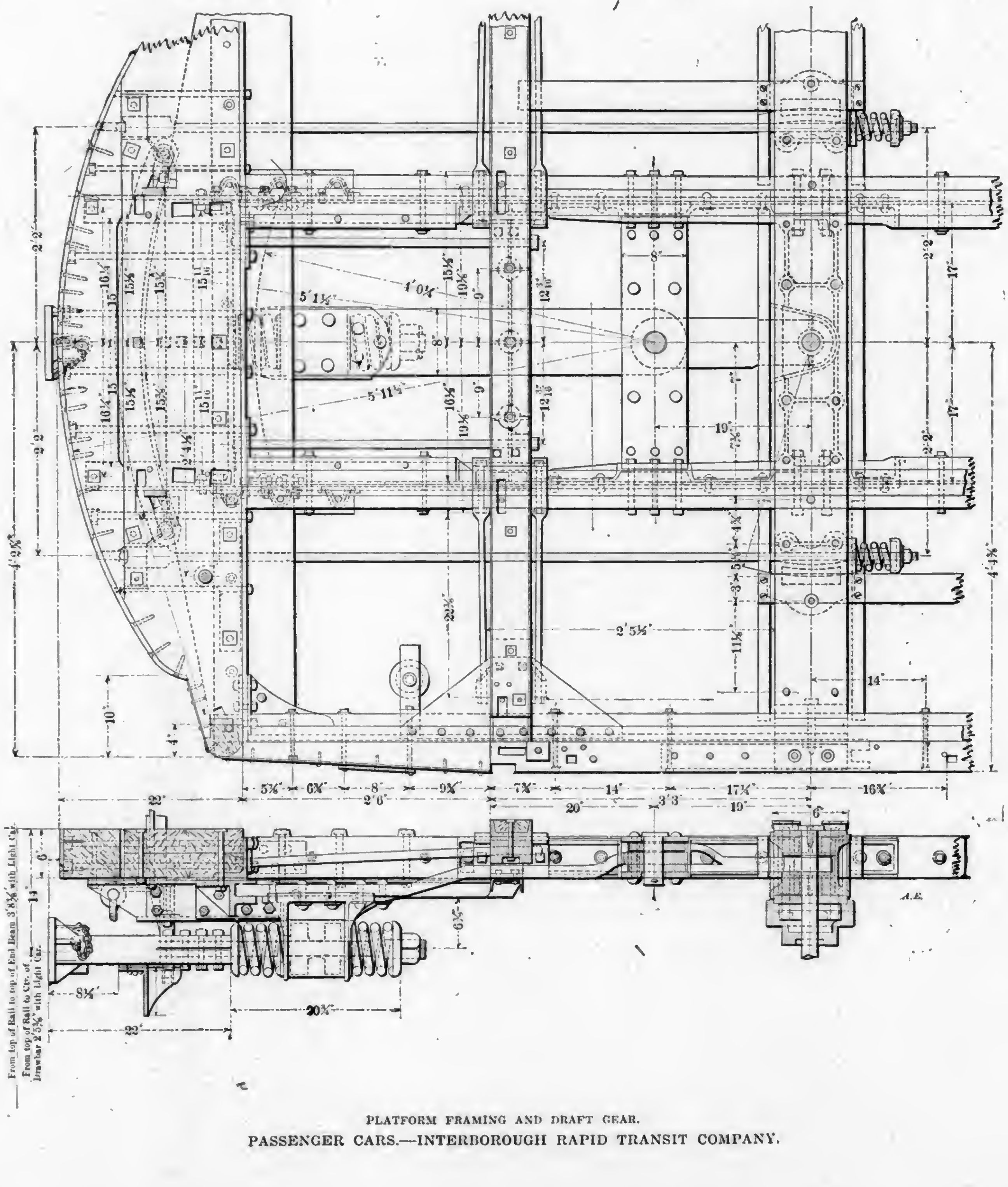
We are indebted to Mr. George Gibbs, consulting engineer, and Mr. W. T. Thompson, master mechanic of the road, for the drawings and information.



BODY BOLSTER.



SECTION NEAR BODY END SILL.



PLATFORM FRAMING AND DRAFT GEAR.

PASSENGER CARS.—INTERBOROUGH RAPID TRANSIT COMPANY.

TEST OF OIL BURNING LOCOMOTIVE.

DISTANCE 1,422 MILES.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

The three-furnace, corrugated firebox, oil-burning locomotive, No. 824, built by the Baldwin Locomotive Works for this road was illustrated on page 10 of this journal for January, 1902. Since the engine went into service the brick setting of the fireboxes has been changed in accordance with the drawing presented herewith.

After the oil-burning devices had been adjusted upon the arrival of the engine at Topeka, it was decided to make a running test with full tonnage in a run of 1,422 miles from Topeka to Needles, Cal., where the engine was to go into regular service. The data were taken by Mr. C. B. Goode, who acted as fireman for the entire trip. Ten engineers served over the various divisions. Oil was carried in a tank car from Topeka and other cars were stationed along the line at Dodge City, Albuquerque and Gallup. The engine tank was filled from the cars by compressed air. Beaumont oil was used over all divisions except the last, from Seligman to Needles, where Bakersfield oil was used. Except between Gallup and Winslow, 128 miles of down grade, full tonnage was hauled all the way. There were no "engine failures" and no trouble whatever except a little difficulty in firing up at one or two points. The boiler was washed out three times on the trip—at La Junta, Raton and Albuquerque. At the other division points the boiler was left full of water over night, and in the morning its own steam was used in firing up.

From Newton to Dodge City the evaporation per pound of oil was lowest. This was because of difficulty in securing the proper adjustment of the two upper burners. In firing oil-burning locomotives the fireman regulates the oil by the color of the smoke at the stack and by the steam gauge. Mr. Goode says: "The only excuses for smoking an oil-burning locomotive are leaky tubes, a leaky firebox or difficulty in adjusting the burners properly." He also says: "Engine 824 has been doing good work on the mountain over a 3½ per cent. maximum grade from San Bernardino to Summit."

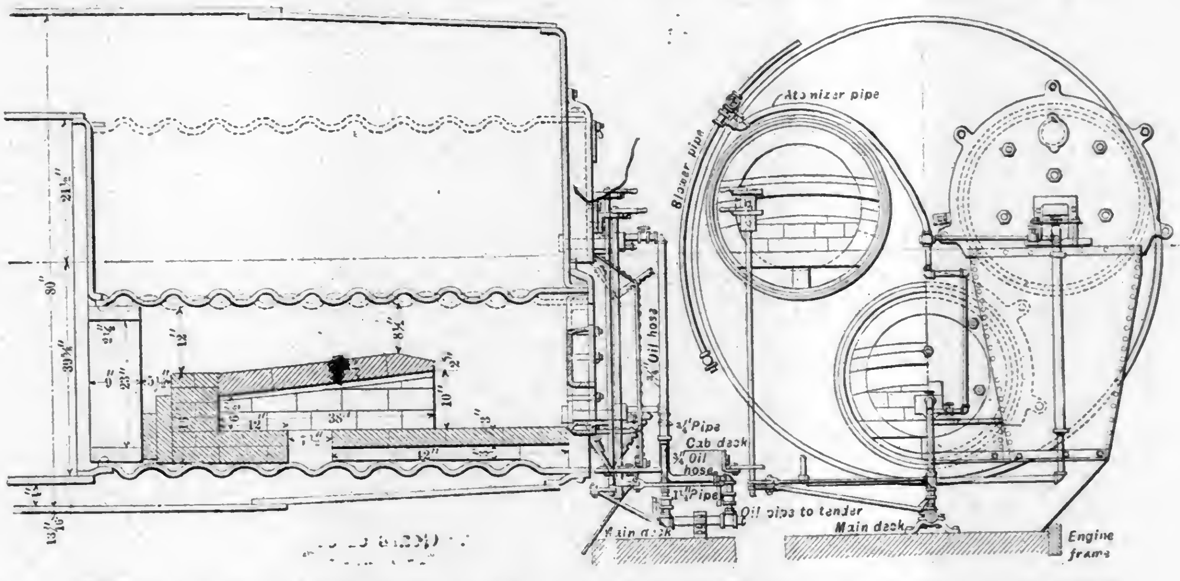
This test does not represent an efficiency investigation of oil fuel, but a running test over a long distance under ordinary road conditions. The data are presented in the accompanying tables. We are indebted to Mr. G. R. Henderson, superintendent of motive power of the Santa Fe, and to Mr. Goode for this information.

OIL AND WATER CONSUMPTION BY ENGINE 824.

Topeka, Kan., to Needles, Ariz., 1,422 Miles.

Left Topeka, May 2, 1902, at 4.40 A. M. Arrived Needles, May 17, 1902, at 1.10 A. M.

Length of time on trip, Topeka to Needles..14 days, 8 hours, 30 minutes
Delays and time not running.............11 days, 1 hour, 35 minutes
Actual running time.....................3 days, 6 hours, 55 minutes
Average speed on trip (running time), miles per hour............18.1
Average tonnage for entire trip ....930 tons
Tons hauled one mile for entire trip ....1,330,631 tons
Total weight oil burned (Topeka to Needles) in tons.........69.9 tons
Total weight water evaporated (Topeka to Needles) in tons..721.6 tons
Water evaporated per lb. oil (Topeka to Needles) in lbs.....10.32 lbs.
Oil burned per ton mile (Topeka to Needles) in lbs........... .105 lb.



FIREBOX SETTING.—LONG-DISTANCE TEST OF A TRIPLE-FURNACE OIL-BURNING LOCOMOTIVE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

THE RECORD BY DIVISIONS.

Division	Topeka to Emporia	Emporia to Newton	Newton to Dodge City	Dodge City to La Junta	La Junta to Raton	Raton to Las Vegas	Las Vegas to Albuquerque	Albuquerque to Gallup	Gallup to Winslow	Winslow to Seligman	Seligman to Needles
Mileage	62	74	167	202	105	111	132	158	128	143	140
Mean grade—feet per mile.	17.2	6.2	7.9	9.	36.4	17.6	17.1	16.	2.	25.	10.
Date	5-2-02	5-2-02	5-3-02	5-4-02	5-6-02	5-8-02	5-9-02	5-11-02	5-11-02	5-14-02	5-16-02
Train No.	29	Extra	3d-33	Extra	1st-33	Local	1st-33	1st-33	Extra	Extra	Extra
Leaving time	4.40 a.m.	5.45 p.m.	6.05 p.m.	11.30 a.m.	11.25 a.m.	9.15 a.m.	11.35 a.m.	4.25 a.m.	8.15 p.m.	7.45 a.m.	4.30 a.m.
Arriving time	9.40 a.m.	1.05 a.m.	3.50 a.m.	5.30 a.m.	8.05 p.m.	12.45 a.m.	9.45 p.m.	5.25 p.m.	3.50 a.m.	8.05 p.m.	1.10 a.m.
Time on road	5 h.	7 h., 20 m.	9 h., 45 m.	18 h.	8 h., 40 m.	15 h, 30 m	10 h, 10 m	13 h.	7 h., 35 m.	12 h, 20 m	8 h., 40 m.
Actual running time	3 h., 50 m.	4 h., 50 m.	7 h., 40 m.	11 h, 20 m	5 h., 50 m.	7 h., 10 m.	6 h., 55 m.	9 h., 40 m.	5 h.	9 h.	7 h., 40 m.
Average speed—miles p. h.	16.2	15.3	21.8	17.8	18.	15.5	19.1	16.4	25.6	15.9	18.3
Tonnage	1,100	2 000	1,273	1,110	545	1,125	635	1,000	25	1,030	700
Number of cars	....	72	....	70	....	42	39	38	1	25	....
Tons hauled one mile	68,200	148,000	212 591	224,220	56,135	124,875	83,820	158,000	3 200	147,290	104,300
Oil burned over division, lbs. (actual)	9,177	11,362	14,044	21,850	10,925	11,799	10,488	17,480	4,807	17,480	10,488
Water evaporated over division, lbs. (actual)	88,096	110,070	127,314	202,515	125,495	133,916	109,495	202,102	54,963	199,692	109,568
Evaporation per lb. oil, lbs.	9.60	9.68	9.06	9.27	11.50	9.66	10.44	11.53	11.43	11.42	10.45
Oil burned per ton mile, lbs.	.134	.078	.066	.098	.194	.094	.125	.110	.150	.102	.101
Oil burned per engine mile, lbs.	148.	154.	84.	108.	104.	106.	79.	111.	38.	122.	70.

MACHINE TOOL PROGRESS.

III.

FEEDS AND DRIVES.

BY C. W. OBERT.

A PORTABLE POSITIVE FEEDING ATTACHMENT.

The preceding articles of this series have dealt with types of variable-speed positive-drive feeding mechanisms which have been built upon machine tools as an essential part, being incorporated in the design of the machine and thus not applicable to any other tool. The National Machine Tool Company, Cincinnati, Ohio, have introduced an independent feeding mechanism, which is of particular interest because it will accomplish the same purpose, yet at the same time is a complete and separate attachment in itself, which is applicable to any lathe equipped with the usual style of quadrant for change gears. It is quickly applied to a lathe and easily manipulated, and will prove invaluable where it is desired to replace the loose change gear system and belt feeds by positive-drive geared feeds in adapting a lathe to the new high-duty tool steels for hard use and profit making.

The accompanying engravings on the opposite page present comprehensive illustrations, front, rear and internal, of this interesting device. It consists of a series of pinions of different sizes mounted within a dust proof case and arranged to all rotate together in mesh with a common intermediate gear, and means of delivering motion from any of the driven pinions through various gear combinations. Fig. 15 shows the arrangement of the nine pinions, E-E, around the common driving gear, F, the front half, M, of the case being removed. The common gear, F, is mounted upon and rotates on the eccentrically located stud, R, on the front half of the frame; it is to be noted that gear, F, is not driven at its hub.

The device is mounted upon a lathe by merely bolting the mounting plate, P, to the lathe's quadrant in place of the intermediate gear, and so adjusting it that the receiving gear, A, may be swung into mesh with the spindle pinion, S. As may be seen in Fig. 15, gear, A, is mounted upon a bracket, J, adjustable concentrically with gear, B, which is driven by A; this facilitates the proper meshing of the gears and also renders the device adaptable to lathes of different designs.

The drive for the gearing is from the spindle pinion, S, of the lathe through gear, A, to gear, B, which is mounted upon a shaft passing through the extension hub, O, of bracket, J, upon which the frame of the gear box is mounted by the hole in stud, R. The opposite end of this shaft is keyed for the driving gear, C, Fig. 13; gear, C, drives the train of gears within the case by means of pinion, D, which may be mounted at will upon either one of two of their extended shafts, 2 or 3, which project out through the front of the case, and are feathered and provided with spring buttons for retaining the gear. As may be seen from the internal view, shaft 3 drives gear, F, at a slower rate, while shaft 2 will drive it at a faster rate; thus, by means of pinion, D, two rates of speed are available, while inasmuch as gears, C and D, are entirely interchangeable four changes of speed may be obtained.

The method of taking motion from any one of the pinions, E, which run at differing speeds in mesh with common gear, F, is by means of jaw clutches, H-H, in the ends of their shafts projecting through the rear half, N, of the case, Fig. 14. Delivery gear, G, may be thrown into connection with any one of those clutches by either one of the corresponding clutches, 5 or 6, which are controlled by knob, K. The case of the gear box may be rotated upon its center bearing, O, after being released by handle, L, in order to bring any one of clutches, H, into line with either 5 or 6.

The purpose of the two clutches, 5 and 6, is for reversal of feeds; when 6 is thrown in and drives feed gear, T, direct, it delivers motion in the same direction in which gear, C, and the spindle of the lathe are rotating, while if 5 is thrown in clutch, feed gear, T, is driven in an opposite direction from that of the lathe's spindle, the reversal of motion being due to the pinion on shaft, 5, driving through pinion, G, as an idler or intermediate. Thus by throwing shaft, 5, into clutch, which is done by turning knob, K, to the left, the carriage of the lathe is given right-hand travel, while throwing in clutch, 6, by turning K to the right gives the carriage left-hand travel.

The proper positions of the case for clutching the various pinions are indicated by marks upon the outer edge, which are brought around to pointer, X, for clutch 5, or to pointer, Y, for clutch 6. The jaw clutches, H-H, and on 5 and 6, are of steel thoroughly hardened so as to be thrown in clutch while the lathe is in motion with perfect safety.

As may be noted in Fig. 15, the stud, R, was located eccentrically upon M in order to allow the larger sizes of the nine pinions, E-E, to be placed all at one side of the common gear, F, and thus permit of a smaller case. The revolving of the case for bringing any of the clutches into line for connecting up is very easily accomplished after releasing the clamping lever, L, by using the hub of gear, D, as a handle, while the proper clutch to use for any particular thread to be cut on the lathe is indicated by the table of gear combinations located on the frame beside knob, K. For the entire range of thread cutting it is only necessary to change gear, D, on the front of the box, twice, all other necessary changes being made by rotating the gear casing and operating the clutches. The drive is always through only two gears in the casing, and the common intermediate, which has its bearing on the long hub, O, within the casing.

For general purposes the thirty regular changes possible are sufficient. On the No. 4 attachment they cover the following threads per inch: 4, 5, 6, 7, 8, 9, 10, 11, 11½, 12, 13, 14, 16, 18, 20, 22, 24, 26, 27, 28, 30, 32, 36, 40, 42, 44, 46, 48, 52 and 56, while the feeds are in proportion. This range is obtained by driving, if the lathe has four threads per inch on the lead screw, from a 36-tooth gear on the spindle or stud to a 48-tooth gear on the lead screw. If a 24-tooth gear is substituted on the screw, one-half the index, or from 2 to 28 threads per inch, can be cut, and coarser feeds obtained. The contrary is also true, of course, and by making the reduction in the size of the driving gear the series will comprise a range of finer threads and feeds. This may be carried out indefinitely. Gears of other proportions are used accordingly as the number of threads per inch on the lead screw may vary; as, for instance, for metric threads a 50-127 pair of gears is used.

The following table gives the gears to be used in driving for the different sizes of feeding attachments. Other gears with the same ratios may, of course, be used:

Size of Attachment.	Spindle or Stud Gear.	Screw Gear.	Pitch of Screw.
No. 3.	24	54	4
	30	54	5
	36	54	6
No. 4.	24	48	4
	30	48	5
	36	48	6
No. 5.	48	48	4
	60	48	5
	72	48	6

Fig. 16 is an illustration of the Schellenbach feeding attachment applied to an engine lathe made by the Bradford Machine Tool Company, of Cincinnati, Ohio. This device is unquestionably a very valuable one and has proven very serviceable, being applicable, as it is, to any lathe. It is of very compact design and is easily handled. It will be of inestimable value in the great task of displacing the old method of belt feeding, with its many objectionable features.

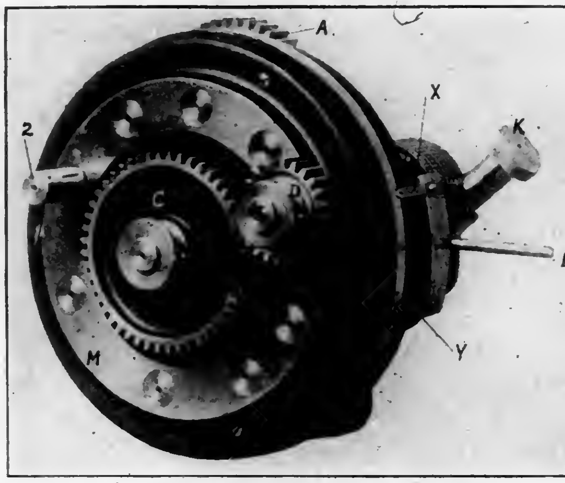


FIG. 13.—GENERAL VIEW OF THE SCHELLENBACH FEEDING ATTACHMENT.

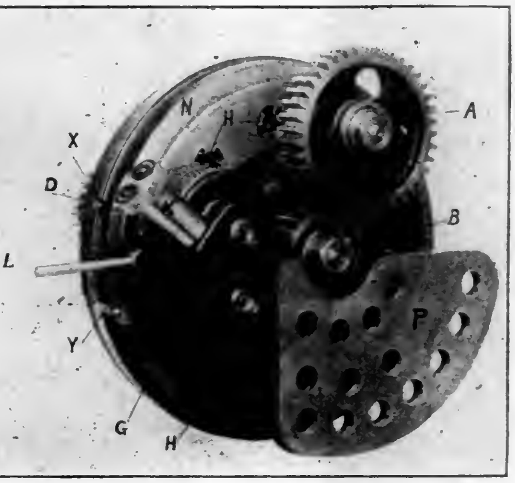


FIG. 14.—REAR VIEW OF FEEDING ATTACHMENT, SHOWING SUPPORTING PLATE.

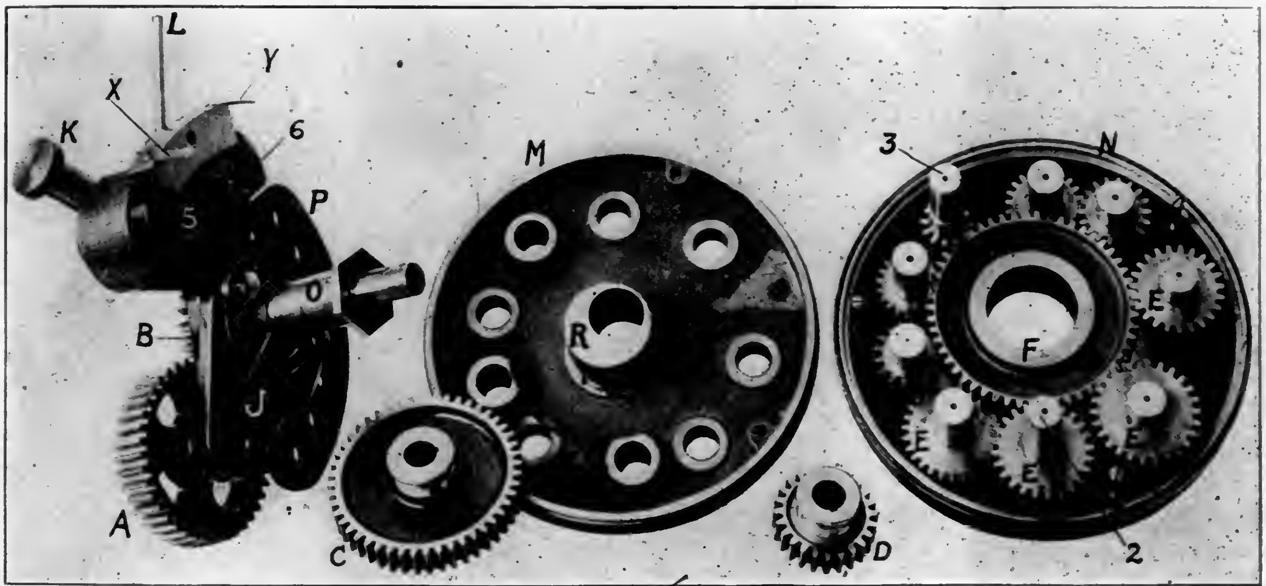


FIG. 15.—INTERNAL VIEW OF FEEDING ATTACHMENT, SHOWING ARRANGEMENT OF THE COMMON INTERMEDIATE GEAR AND MULTI-SPEED PINIONS.

FIG. 16.—VIEW OF THE FEEDING ATTACHMENT MOUNTED UPON AN ENGINE LATHE OF THE BRADFORD MACHINE TOOL CO.

MACHINE TOOL PROGRESS.—SCHELLENBACH FEEDING ATTACHMENT.

MACHINE TOOL PROGRESS.

III.

FEEDS AND DRIVES.

BY C. W. OBERT.

A PORTABLE POSITIVE FEEDING ATTACHMENT.

The preceding articles of this series have dealt with types of variable-speed positive-drive feeding mechanisms which have been built upon machine tools as an essential part, being incorporated in the design of the machine and thus not applicable to any other tool. The National Machine Tool Company, Cincinnati, Ohio, have introduced an independent feeding mechanism which is of particular interest because it will accomplish the same purpose, yet at the same time is a complete and separate attachment in itself, which is applicable to any lathe equipped with the usual style of quadrant for change gears. It is quickly applied to a lathe and easily manipulated and will prove invaluable where it is desired to replace the loose change gear system and belt feeds by positive-drive geared feeds in adapting a lathe to the new high duty tool steels for hard use and profit making.

The accompanying engravings on the opposite page present comprehensive illustrations, front, rear and internal, of this interesting device. It consists of a series of pinions of different sizes mounted within a dust proof case and arranged to all rotate together in mesh with a common intermediate gear, and means of delivering motion from any of the driven pinions through various gear combinations. Fig. 15 shows the arrangement of the nine pinions E-E around the common driving gear, F, the front half, M, of the case being removed. The common gear, F, is mounted upon and rotates on the eccentrically located stud, R, on the front half of the frame; it is to be noted that gear, F, is not driven at its hub.

The device is mounted upon a lathe by merely bolting the mounting plate, P, to the lathe's quadrant in place of the intermediate gear and so adjusting it that the receiving gear, A, may be swung into mesh with the spindle pinion, S. As may be seen in Fig. 15, gear, A, is mounted upon a bracket, J, adjustable concentrically with gear, B, which is driven by A; this facilitates the proper meshing of the gears and also renders the device adaptable to lathes of different designs.

The drive for the gearing is from the spindle pinion, S, of the lathe through gear, A, to gear, B, which is mounted upon a shaft passing through the extension hub, O, of bracket, J, upon which the frame of the gear box is mounted by the hole in stud, R. The opposite end of this shaft is keyed for the driving gear, C, Fig. 13, gear, C, drives the train of gears within the case by means of pinion, D, which may be mounted at will upon either one of two of their extended shafts, 2 or 3, which project out through the front of the case, and are feathered and provided with spring buttons for retaining the gear. As may be seen from the internal view, shaft 3 drives gear, F, at a slower rate, while shaft 2 will drive it at a faster rate; thus, by means of pinion, D, two rates of speed are available, while inasmuch as gears C and D are entirely interchangeable four changes of speed may be obtained.

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	30	54	5
	36	54	6
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	36	48	6
No. 5.	48	48	4
	60	48	5
	72	48	6

Fig. 16 is an illustration of the Schellenbach feeding attachment applied to an engine lathe made by the Bradford Machine Tool Company, of Cincinnati, Ohio. This device is unquestionably a very valuable one and has proven very serviceable, being applicable, as it is, to any lathe. It is of very compact design and is easily handled. It will be of inestimable value in the great task of displacing the old method of belt feeding, with its many objectionable features.

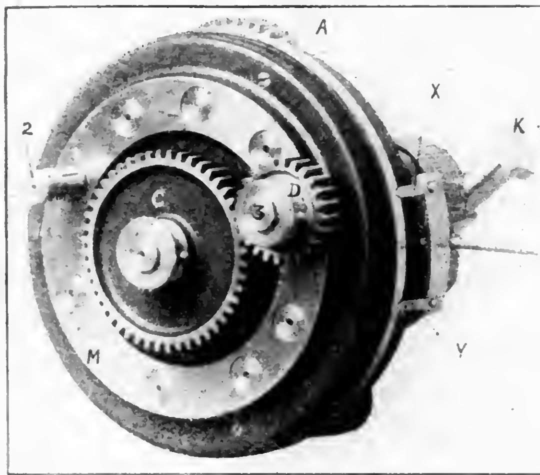

FIG. 13.—GENERAL VIEW OF THE SCHELLENBACH FEEDING ATTACHMENT.

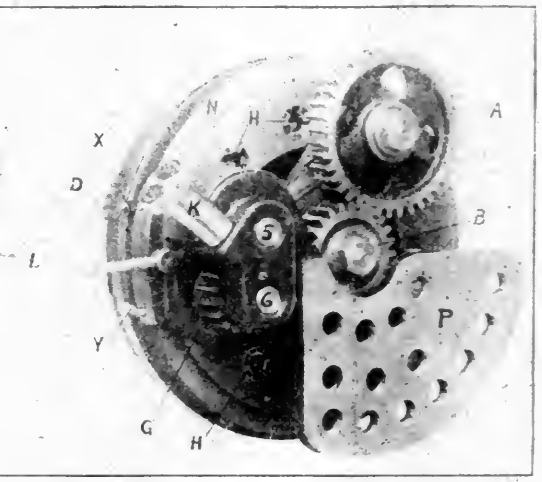

FIG. 14.—REAR VIEW OF FEEDING ATTACHMENT, SHOWING SUPPORTING PLATE.

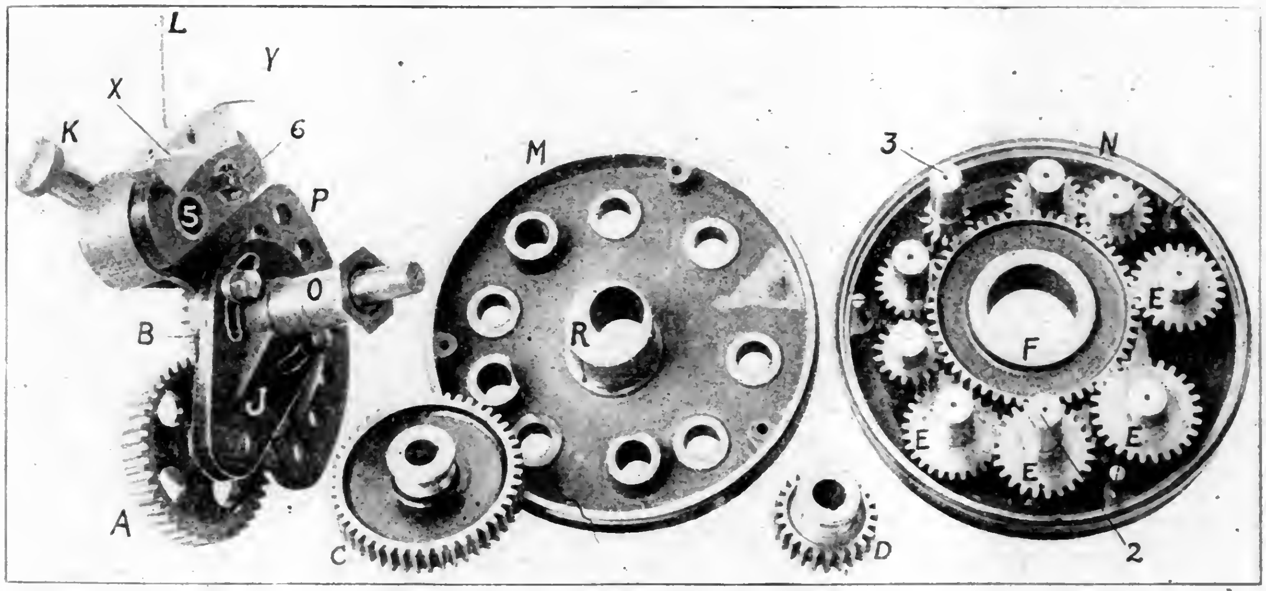

FIG. 15.—INTERNAL VIEW OF FEEDING ATTACHMENT, SHOWING ARRANGEMENT OF THE COMMON INTERMEDIATE GEAR AND MULTI-SPEED PINIONS.

FIG. 16.—VIEW OF THE FEEDING ATTACHMENT MOUNTED UPON AN ENGINE LATHE OF THE BRADFORD MACHINE TOOL CO.

MACHINE TOOL PROGRESS.—SCHELLENBACH FEEDING ATTACHMENT.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

H. G. PROUT.

The resignation of Colonel Prout after sixteen years as editor-in-chief of the *Railroad Gazette* is a distinct loss to the profession of technical journalism. To the Westinghouse interests, whose service he enters as vice-president and general manager of the Union Switch and Signal Company, there is a corresponding gain, and thus another general officer with an international reputation is secured to the staff presided over by Mr. George Westinghouse, again testifying to his ability to surround himself with the ablest men. Colonel Prout combines natural ability, attractive and polished personal traits, general information and a broad minded manner of dealing with large questions, in a way which has brought him distinction as an engineer, both at home and abroad, honor as a man and a position of great respect and powerful influence as an editor. His experience includes service in the Civil War, education as an engineer, commissions of responsibility in the Soudan, where he was an assistant and associate of General Gordon, commercial business in New York and his long and successful editorial charge of the *Railroad Gazette*. His name takes a worthy place with those of Messrs. Dunning, Forney and Wellington. He has effectively employed his ability to write and to speak in public and has placed his high professional and personal ideals before many bodies of men and engineering students through his lectures and addresses as well as his writings. He has served as an educator to prospective engineers in the problem of facing the world and has furnished them an inspiring example. He has also been prominent in the most important work of the American Society of Civil Engineers. His hosts of friends cannot wish him more success in the future than has always attended him. It is regretted that Colonel Prout retires from the leading position in this profession, the standard and dignity of which he has done so much to improve.

THE MATTER OF MOTIVE POWER SALARIES.

If all of the motive power superintendents in the country should resign simultaneously to-day the managements of the railroads would have at least three surprises.

The motive power department would be discovered to be most important and most neglected, from a business point of view.

It would be found impossible to secure the right men to fill the positions immediately, as these men are not in training.

The heads of these departments would be in demand among industrial establishments at from two to three times their present salaries.

It would be a blessing to the railroads to have this very thing happen. It would reveal a state of weakness which the real owners of the properties need to understand. They need to know that most railroads do not for a moment consider promotion from the staff to fill the position of the chief; that these officers are not as a rule encouraged to pursue a business policy in their departments and that the position of superintendent of motive power demands a grade of ability and a fund of experience which are sought for and paid for appropriately by the "captains of industry."

How simple are the specifications for the men who would be so greatly needed! They must be masters of men and thorough students of the labor problem. They must be able engineers. They must be business men. They must be organizers of campaigns far more complicated and more difficult than those which have won the praise of nations for military successes.

Granting that every motive power department has such a man at its head to-day—what about the future? What is there

about the present situation to attract and stimulate the ambition of the best mechanical talent of the times to prepare for these responsibilities and truly great opportunities? These questions need attention, and they need it now.

Because of its source and its clear expression the following letter to the editor from a successful superintendent of motive power, now retired from railroad service, is presented here, and it needs no comment:

"I have been quite impressed by the article on the editorial page of your January number, on the subject of inadequate pay of motive power officers in the United States. I think you state the proposition fairly, and it exactly fits the conditions which many have experienced in this line of work. I venture to state that many a mechanical officer in his reflections upon the 'state of things' has seen pictured in his mind, 'He who enters here leaves all hope behind.' If not in exact phrase, he has seen it at least in substance.

"I remember, a good many years ago, while hanging over a drawing board, of being advised by my professor to the effect that if I did that work well to be sure to let no one know it, as I would certainly be kept at it. I feel that the mechanical department has been 'kept at it' so long as a result of the present system that there is a great dearth of suitable men to fill the positions now being offered.

"Many a chief clerk in the mechanical department has gone around and up, due to the needs of some other department, while the 'boss' is pulling, discontentedly, at the end of his rope. It would seem almost a waste of money for a young man to attempt to fit himself for a mechanical position on some of the American railroads, as he could do just as well in some other department, given the same amount of sense, without going through a technical school.

"The mechanical officers have done well, as the shops and equipment show in many cases, when we consider how subordinate the department is on some lines. I know of a recent case where a motive power superintendency on a road having about 700 engines was offered at $5,000, and possibly 'might' pay $6,000 per year. The position is a hard one, labor conditions most difficult and the intelligent advice needed for dependent lines an indefinite quantity. I believe, however, no mention was made in this case of a 'tenor voice' among the requisites. What a prize to draw!

"As you have said, ' the gates to higher positions must be thrown open.' This will not be done by those most immediately superior to the mechanical department by relinquishing voluntarily the authority which they have so long enjoyed. It must come from the top and the mechanical department must be brought into 'close harmony' with the highest officials and recognized as a necessary and prime part of the organization instead of a nuisance of secondary importance—to be just tolerated. I know of railroads on which the effort to keep the mechanical department in the background is not often lost sight of and would be almost comical, if it were not for the uncomfortable position which the department occupies.

"I remember, some years ago, meeting Mr. Worsdell, mechanical superintendent of the North Eastern Railway, in York, England. He said that he would be pleased to be of service to me as soon as a certain meeting of the directors which he was in York to attend was over. While I do not suppose such a condition as motive power officials being asked to meet the board of directors is likely to become common in the United States, nevertheless this incident speaks volumes as to what the relation between the mechanical and the other departments should be.

"It cannot be contended that all mechanical departments are properly run or that every man who happens to be head of a mechanical department is a genius, but the mechanical department is a vital element in railroad organization and should be so recognized. A competent and trusted man with sufficient compensation should be put at its head, one who will not look upon the future as hopeless on account of the existence of a bar to his advancement. Some railroads have done this. I hope more will follow. I feel that I may speak to you on this subject, as I am not a candidate for the good things which may open to the mechanical department—'some day'."

With cars accumulating upon so many sidetracks for want of locomotives to move them, the suggestion of Mr. Herbert T. Herr in his article on page 83 of this number is opportune. If the only recognition of the time element in freight service, so far as the crews are concerned, is the payment of "overtime," there is not only no incentive for prompt and efficient work, but rather a premium upon the opposite of these.

Mr. Herr suggests placing a premium upon acceleration of train movements and in a way which seems likely to bring out a concerted effort of enginemen, trainmen and dispatchers to accomplish it. Train service is a complicated one, involving many elements and presenting many difficulties in the way of a general improvement like this one, but the proposed method seems worthy not only of discussion but of actual trial. It will, of course, be necessary to pay overtime for delayed crews, but there seems to be no objection to paying an equal or a higher premium for getting in on time. It is reasonable to suppose that such a plan would result in a large reduction in the time lost by a few minutes here and there, which amounts to many hours in the course of a month and on a long division.

This suggestion involves the principle of "piecework" in securing the maximum output of machinery. It would undoubtedly have the same effect on the road as in the shop, and its application to train service cannot be more difficult than in building or repairing locomotives and cars. It would seem to be much easier to apply to trains. It will be interesting to know what the readers think of this.

The voluntary loyal support of workmen is needed in order to secure the desired results from them. This cannot be had in any shop unless a tradition of fair treatment exists, and neither piece-work nor anything like it can succeed in the absence of such a tradition. The unwritten law of business must begin at the top. "One-man power" of the right sort will accomplish this result. Mr. J. F. Deems has said: "I believe the power that succeeds is the one-man power where the one man, by his example, by his tact, by his judgment, by his sense of justice and right, by his love for his fellow men and of the business he is engaged in, by his enthusiasm and personal magnetism, controls and leads the hundreds and thousands of other men without their knowing it."

The question is, How can men be brought into the frame of mind which makes them a part of the company instead of being mere servants?

A division superintendent was complaining about the delay to through freight trains in a yard for inspection. This suggested to the superintendent of motive power the possibility that the inspection at that point was unnecessarily rigid, and it was decided to have the trains looked over for safety on arrival and the brakes set by the engine hauling the train into the yard. If the next engine, when coupled on to haul the train out on its further journey, is able to release all the brakes the train proceeds at once. Cars which will not release have their brakes cut out and are carded, but the train goes on and such cars are set out for repairs at the first convenient point. This works well and saves a lot of time.

The importance of counteracting the momentum of rapidly moving parts of reciprocating machine tools is only beginning to be realized. Considerable attention was given to this at the Collinwood shops, several of the motor-driven planers, shapers and slotters having been equipped with flywheels to overcome the inertia effects in reversing. This is discussed on pages 102-103.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

VI.

INDIVIDUALLY DRIVEN MACHINE TOOLS.

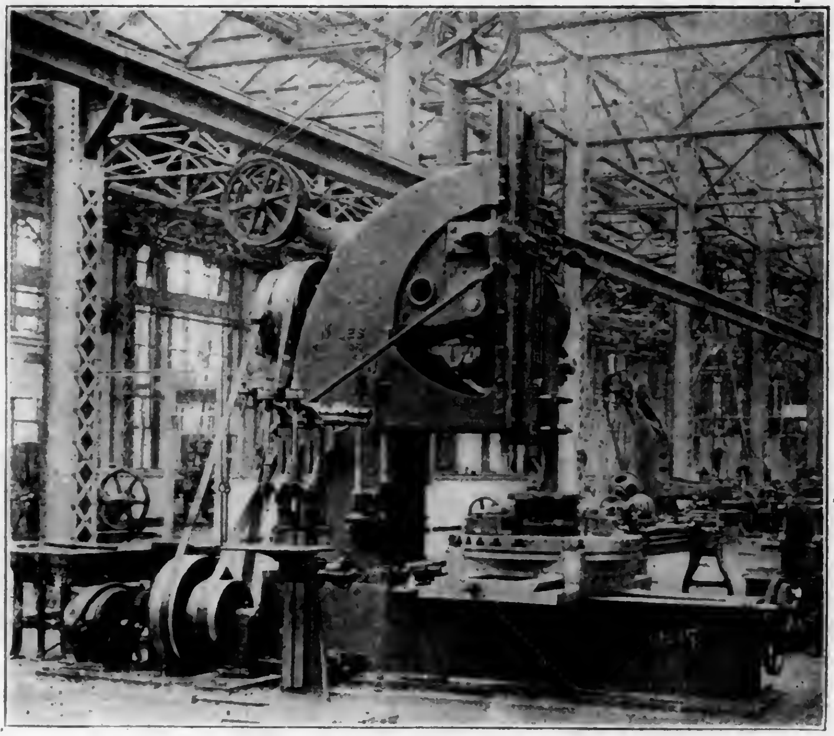
A NEW APPLICATION OF THE PRINCIPLE OF MOMENTUM IN DRIVING RECIPROCATING TOOLS.

One of the most difficult problems met in the applications of motors for the individual driving of the machine tools at the Collinwood shops was that involved in the driving of reciprocating machines, such as planers, slotters and shapers. Most of such tools are provided with quick return motions of the table or ram, and it is a well-known fact that such reversals, in all cases, bring very heavy instantaneous demands for power. Upon tools of this type this results in bringing, at intervals, heavy surges of current into the motor—in fact, so heavy that the overload-release circuit-breaker protecting the motor must necessarily be set for a current several times greater than that normally required.

Actual power input tests that have been made upon motor-driven planers have shown that a Niles 10-ft. x 10-ft. x 20-ft. planer, machining cast iron with three cutting tools and requiring 26-h.p. at the motor on the cutting stroke, brought a demand for 43-h.p at the instant of reversal, while only 24-h.p. were required for the balance of the quick return stroke at a speed of three times that of the forward stroke. An 8-ft. x 8-ft. x 20-ft. Pond motor-driven planer, which required 15-h.p. on the cutting stroke while machining cast iron, demanded a surge of current amounting to 29 h. p. at the instant of reversal of the platen, while the remainder of the 3 to 1 quick return stroke was made with only 14-h.p.

An extreme case of this kind was developed at the works of the William R. Trigg Company, Richmond, Va., in an attempt to drive direct, by a 15-h.p. Crocker-Wheeler multiple voltage motor, a 36-in. planer which was geared up for a cutting speed of 30-ft. per min. and a reversal speed of 75-ft. per min. Power input tests showed that the average power required for the cutting stroke was only 8-h.p, while at the instant of reversal an extreme demand for current was made amounting to over 40-h.p.—a momentary overload of 250 per cent.; a reduction of the platen speeds of the machine by one-half, from 30 and 75 ft. per min. down to 15 and 37½ ft. per min. resulted in bringing the overloading down more than one-half, within the overload limit of the motor. These figures show very plainly that it is not the quick return motion of the table that causes the extra demand for power, but rather that the surge of power is required in overcoming the inertia of the moving parts in forward motion, including the platen and the rapidly revolving pulleys, for the reversal.

It is the opinion of a great many that this heavy inertia effect originates in the rapidly moving pulleys used in connection with the reversing mechanism rather than in the movement of the planer's platen, so that if the pulleys used in the drive be made as light as possible and a heavy fly-wheel be used on the motor's shaft the inertia will be reduced somewhat and partially prevented from taking effect upon the motor. Experiments made in this direction show that a decided gain is effected by such an application of a fly-wheel to the motor's shaft, so as to assist with its stored energy of rotation in supplying the demand made for power at the instant of reversal. On a 60 x 60-in. x 12-ft. Pond motor-driven planer it was found that, by mounting a 42-in., 1500-lb. fly-wheel on the motor's shaft which ran at 400 rev. per min., the power demanded at the instant of reversal of the platen was only 2-h.p. greater than that required for the quick return, which was 14-h.p., the power required during the cutting stroke being 10-h.p. In another case a 30-in. fly-wheel, weighing 500 lbs., was applied to the shaft of a motor which ran at 800 rev. per min., driving a 28 x 32-in. x 6-ft. Gray planer, and the power demanded at the instant of reversal of the platen was found to be only 4.5-h.p., the power required for the cutting stroke



24-IN. GEARED SLOTTING MACHINE.—NILES TOOL WORKS CO.
SPECIAL FLYWHEEL DRIVE FROM A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

DETAIL VIEW OF MOTOR AND FLYWHEEL.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

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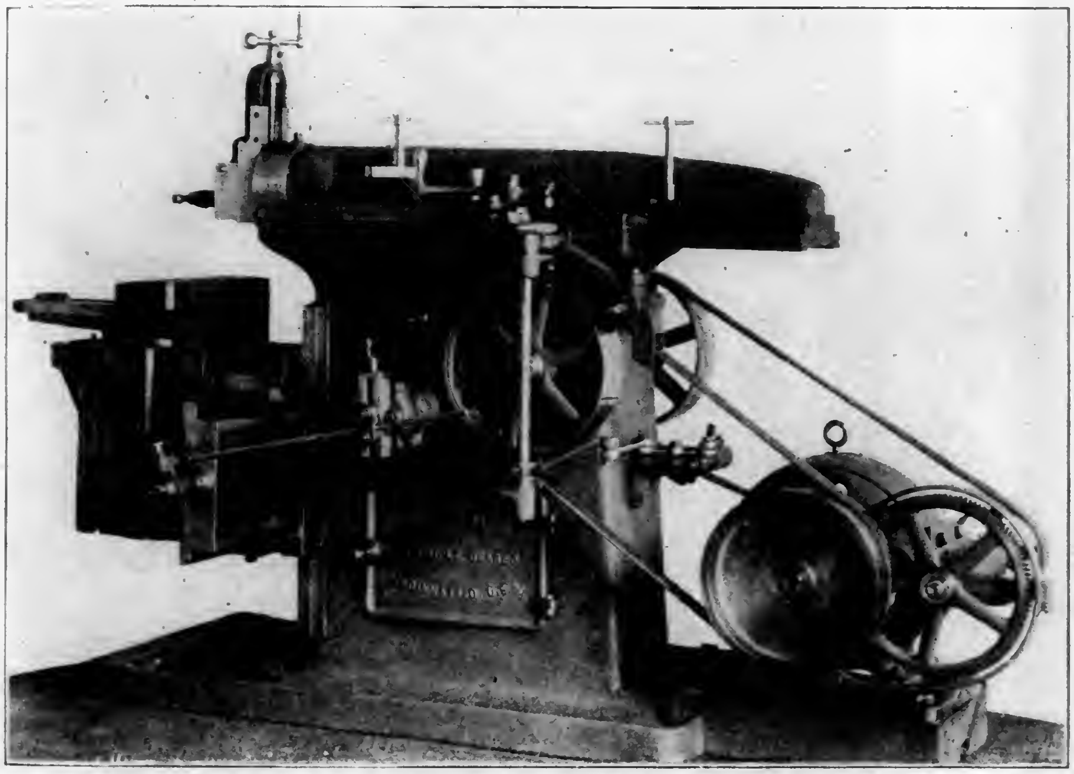
In the Collinwood shops installation the question of fly-wheels received particular attention, several of the reciprocating machines being equipped with fly-wheels at the motors, and several machines of this type have been thus equipped since their installation. On page 102 is an illustration of the 24-in. Niles geared slotting machine which has a fly-wheel as an auxiliary to the motor. The detail view at the right gives an idea of the method of applying the fly-wheel; it is mounted upon a shaft which is driven by the motor through a reduction gearing, the latter shaft serving as the drive for the machine. The application of this wheel presented no interference with the regular drive of the machine inasmuch as the fly-wheel is used as the belt wheel for the quick return motion of the ram.



26-INCH TRIPLE-GEARED RACK SHAPER.—CINCINNATI SHAPER CO.. SPECIAL FLYWHEEL DRIVE FROM A 3-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.

One of the most interesting of the fly-wheel drives is that on the 26-in. triple-geared shaper, shown herewith, which was built and equipped with the fly-wheel drive by the Cincinnati Shaper Company, Cincinnati, Ohio. The motor, which is of the back-geared type, is mounted on an extension of the machine's bed, the drive being by the usual shifting belts direct to the driving pulleys. A heavy fly-wheel is mounted direct upon the extended armature shaft and is utilized as the belt wheel for the quick return motion, while the forward motion for the cutting stroke is obtained through the single reduction gearing. This method is simple and avoids any mechanism other than would be required for a countershaft and belt drive—indeed it is difficult to imagine a more direct method of accomplishing the result desired in this case.

The engraving at the left presents a view of the 36-in. Pond planer which was formerly driven from the motor through an ordinary spoked belt wheel, but has since been equipped for the fly-wheel effect by the bolting in of circular-shaped weights within the rim on each side of the spokes. In this manner the desired result was accomplished without disturbance to the machine. The 54-in. Pond motor-driven planer, illustrated in the lower view upon page 104 presents another example of the fly-wheel driven reciprocating tool. In both of the latter planer cases the fly-wheel is not mounted upon the shaft of the motor, but upon an intermediate shaft which is driven from the motor through reduction gearing.

THE MACHINE TOOLS.

The accompanying illustrations of the machine tools present further representative examples of the motor-driving equipments installed at Collinwood, in addition to those illustrated in the preceding article of this series. The motor mounting is shown on all of the machines, but in many cases it was found impossible to so choose the views as to show the electrical controlling apparatus, on account of their being located on opposite sides of the tool.

The slotting machine illustrated on page 102 is the 24-in. geared slotter (tool No. 19) made by the Niles Tool Works Company, and is driven by a 7½-h.p. Crocker-Wheeler multiple-voltage motor. The motor mounting is independent of the tool, being located upon a separate base upon the floor, and the controlling switches, starter, etc., are conveniently located for the operator on the opposite side of the tool. This slotter is

36-IN. X 36-IN. X 10-FT. PLANER.—POND MACHINE TOOL CO. SPECIAL FLY-WHEEL DRIVE FROM A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

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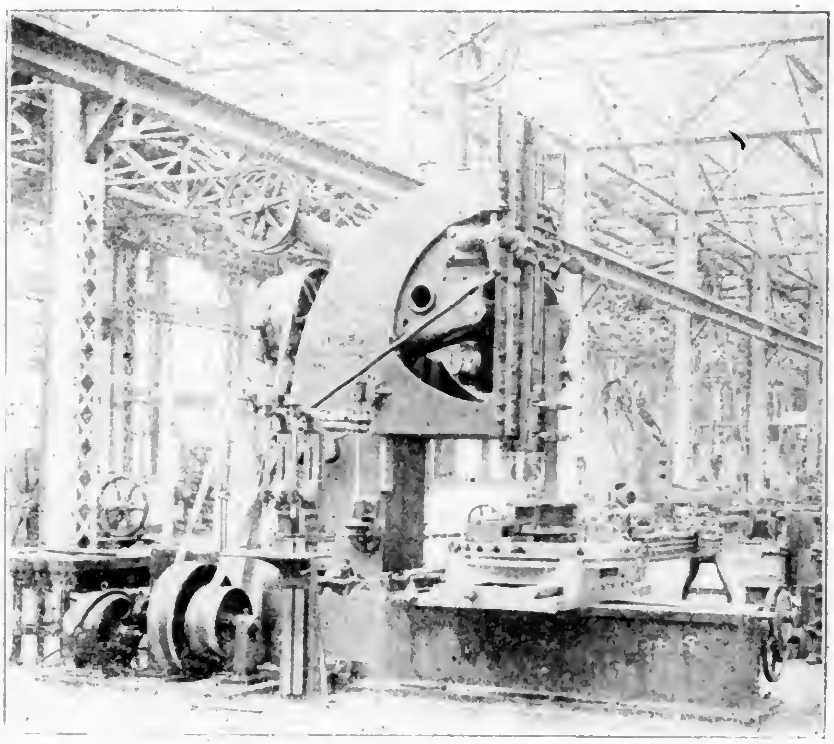

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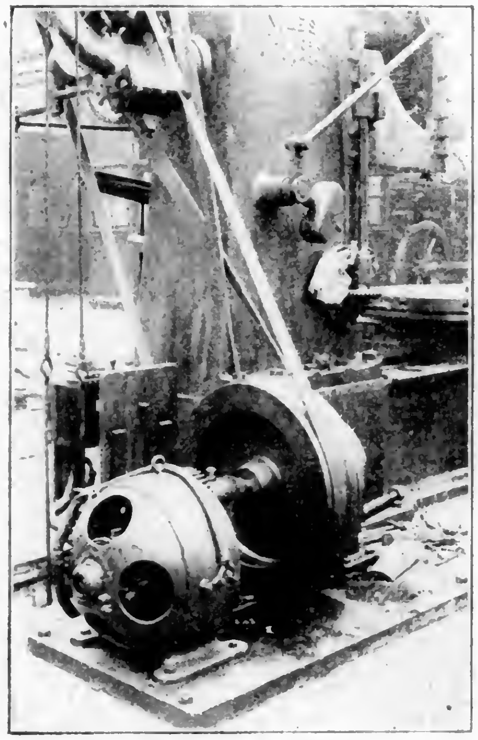

DETAIL VIEW OF MOTOR AND FLYWHEEL.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY

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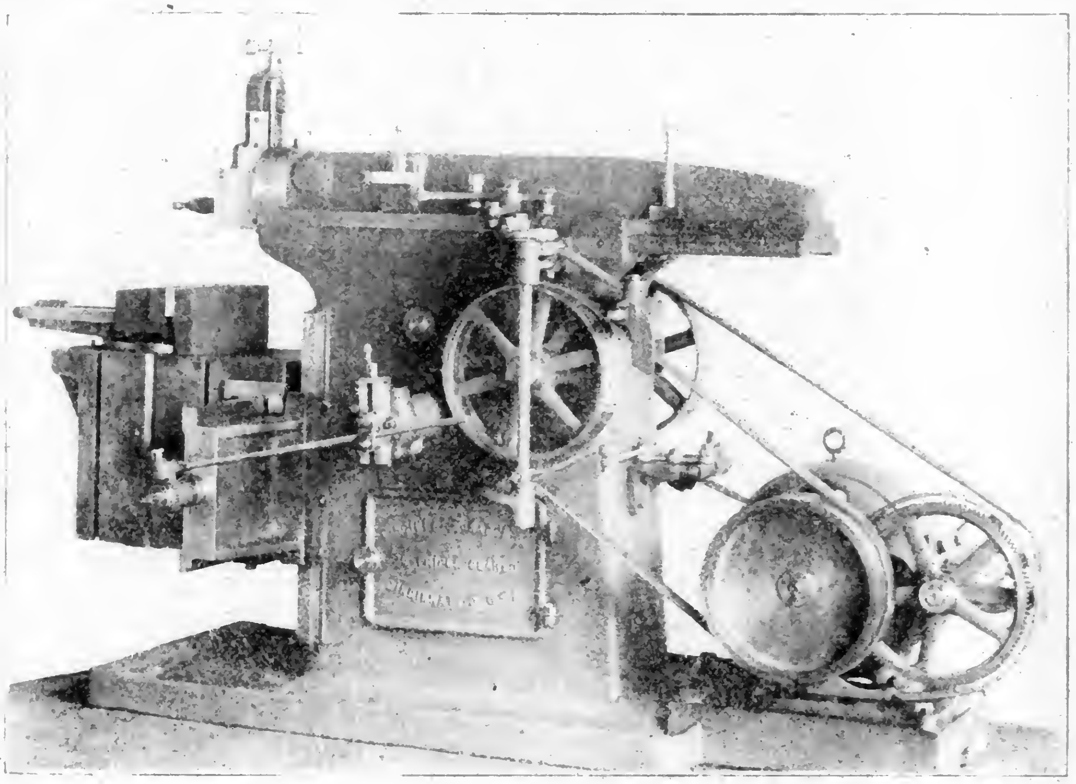

26-INCH TRIPLE-GEARED BACK SHAPER.—CINCINNATI SHAPER CO. SPECIAL FLYWHEEL DRIVE FROM A [illegible]-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.

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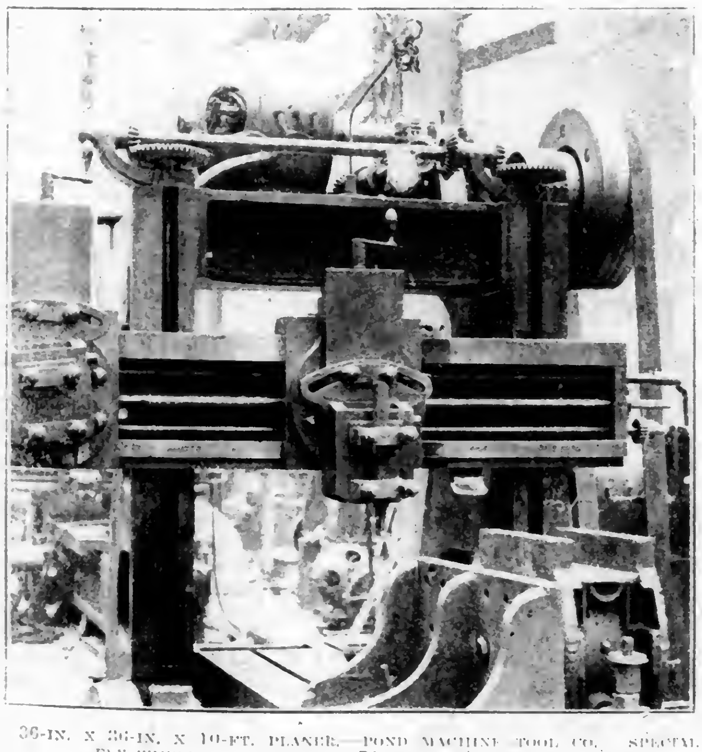

36-IN. X 36-IN. X 10-FT. PLANER.—POND MACHINE TOOL CO. SPECIAL FLY-WHEEL DRIVE FROM A 7½-H.P. MULTIPLE VOLTAGE CROCKER-WHEELER MOTOR.

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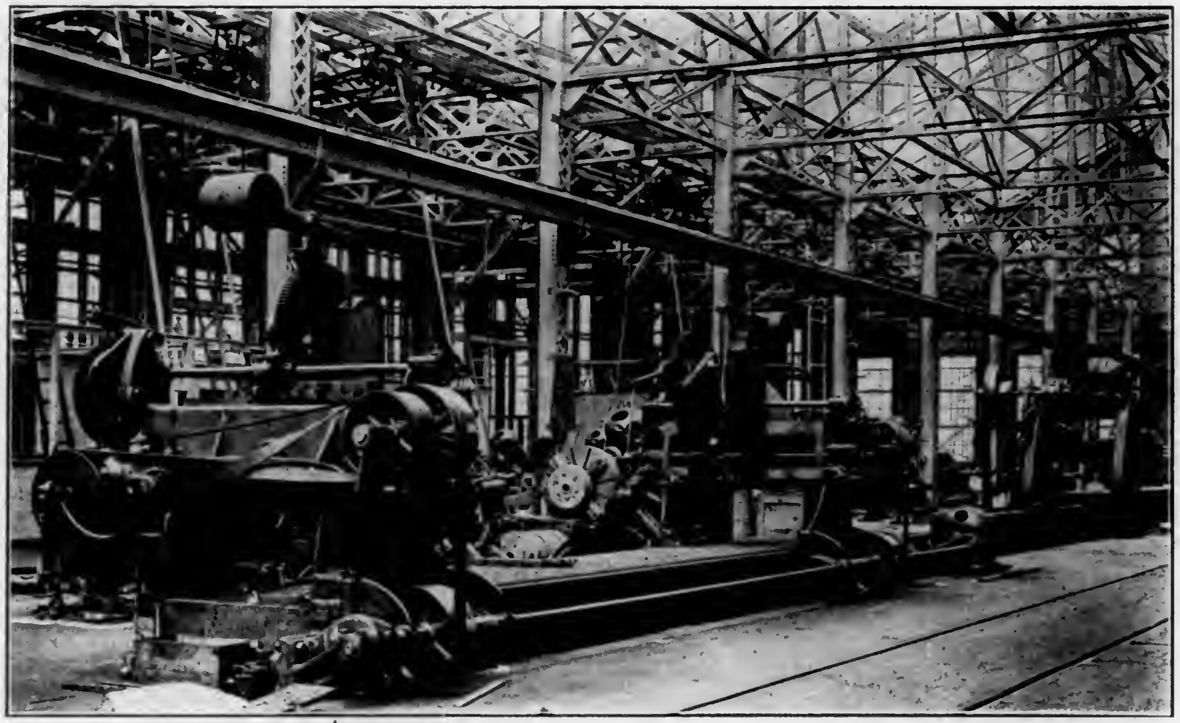
THE MACHINE TOOLS.

The accompanying illustrations of the machine tools present further representative examples of the motor-driving equipments installed at Collinwood, in addition to those illustrated in the preceding article of this series. The motor mounting is shown on all of the machines, but in many cases it was found impossible to so choose the views as to show the electrical controlling apparatus, on account of their being located on opposite sides of the tool.

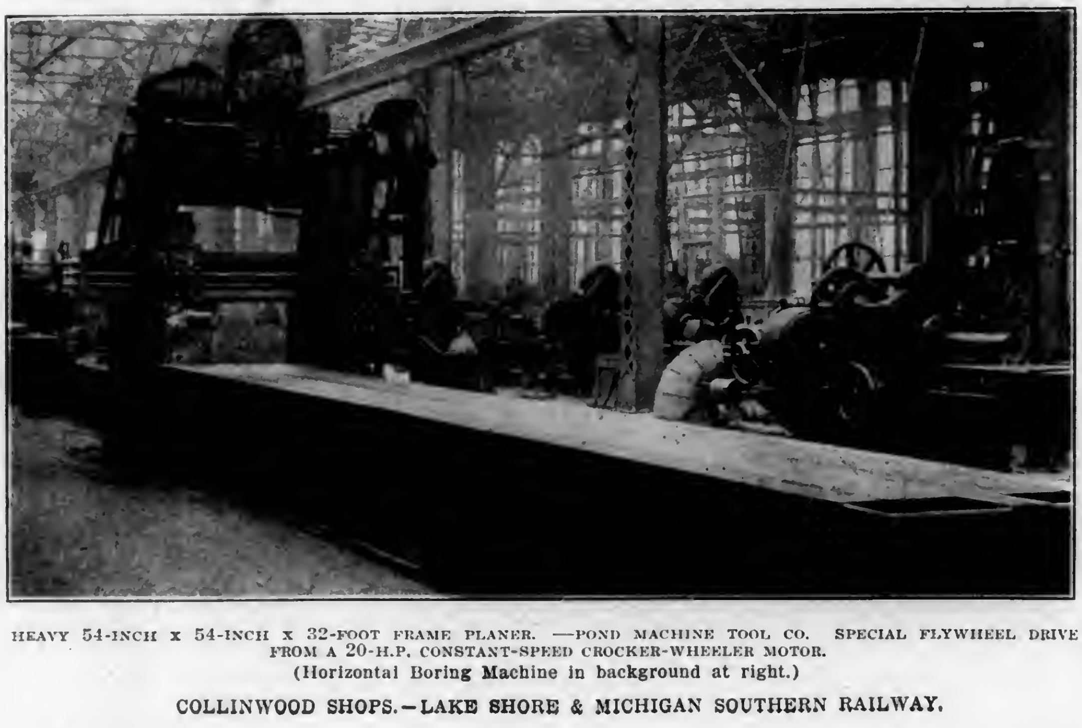
The slotting machine illustrated on page 102 is the 24-in. geared slotter (tool No. 191) made by the Niles Tool Works Company, and is driven by a 7½-h.p. Crocker-Wheeler multiple voltage motor. The motor mounting is independent of the tool, being located upon a separate base upon the floor, and the controlling switches, starter, etc., are conveniently located for the operator on the opposite side of the tool. This slotter is

geared for heavy forge work, the ram being driven by rack and pinion, with tangent gearing at the side. The circular table is 50 ins. in diameter and has 40 ins. longitudinal feed and 36 ins. cross feed, the feeds always taking place at the top of the ram's stroke.

The motor-driven shaper illustrated on page 103 is a 26-in. triple-geared shaper of the rack type (tool No. 82) made by the Cincinnati Shaper Company, Cincinnati, Ohio, the motor used for driving it being a 3-h.p. constant-speed Crocker-Wheeler motor. As regularly built for belt drive, the pulleys for the forward and return motions of the ram are placed on the front side of machine; but in order to have the same relative pulley speeds with motor drive as given by belts, the pulley for the reverse or backing motion of ram is placed on front side of the machine, and is driven directly from the fly-wheel on the armature shaft, and the pulley for the cutting or forward motion of the ram is placed at the back and is driven by a pulley on a back shaft, the bearings for which are bolted to the motor frame. The gear on the back shaft runs in mesh with a rawhide pinion attached to the armature shaft, the ratio between the gears and the driving pulleys being such as to give the proper relation between the cutting and reverse speeds of the ram. The design of this shaper involves many interesting features. The head swivels to any angle, being graduated, and is pro-



DOUBLE HEAD LOCOMOTIVE FRAME SLOTTING MACHINE.—BEMENT, MILES & CO. DRIVEN BY A 20-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.
(Heavy 54-inch Frame Planer in background at right.)



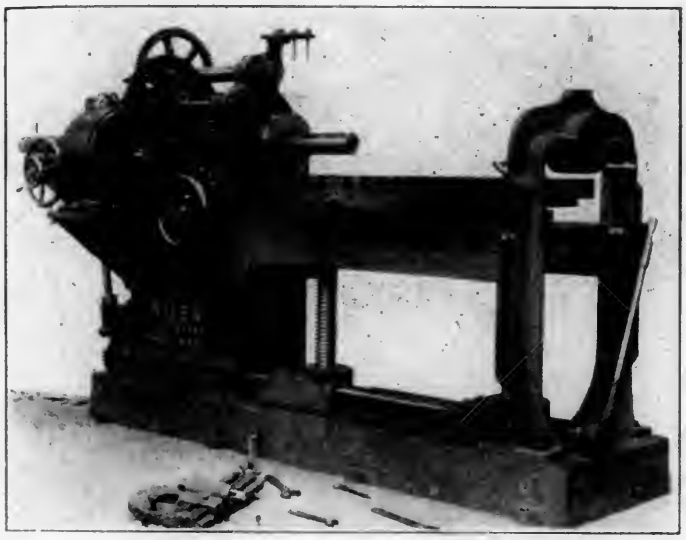
HEAVY 54-INCH x 54-INCH x 32-FOOT FRAME PLANER. —POND MACHINE TOOL CO. SPECIAL FLYWHEEL DRIVE FROM A 20-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.
(Horizontal Boring Machine in background at right.)

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

vided with an automatic down-feed, the screw for which is provided with a graduated collar reading to .001 in. The vise is of a special design in which the fixed jaw extends down to a scraped bearing on the table, thus providing an unusually large footing. Ball bearings are used under the elevating screw for the rail, and also the length of the stroke is very easily changed while the machine is in motion.

The 36-in. planer (tool No. 17) illustrated on page 103, as well as the 54-in. planer (tool No. 15) shown on page 104, are motor-driven planers built by the Pond Machine Tool Company, the former driven by a 7½-h.p. multiple-voltage, and the latter by a 20-h.p. constant-speed Crocker-Wheeler motor. The table of the latter planer is driven by a train of cut gearing and rack mounted in bearings and from a crossed belt for the cutting and an open belt for the return motion by means of a shaft driven by an electric motor on the arch. The belt-shifter guides one belt entirely off the pulley before starting the other on, permits stopping the table instantly from either side without stopping the belts, and is arranged to clear the reversing dog, allowing the work to be run from under the tool for inspection.

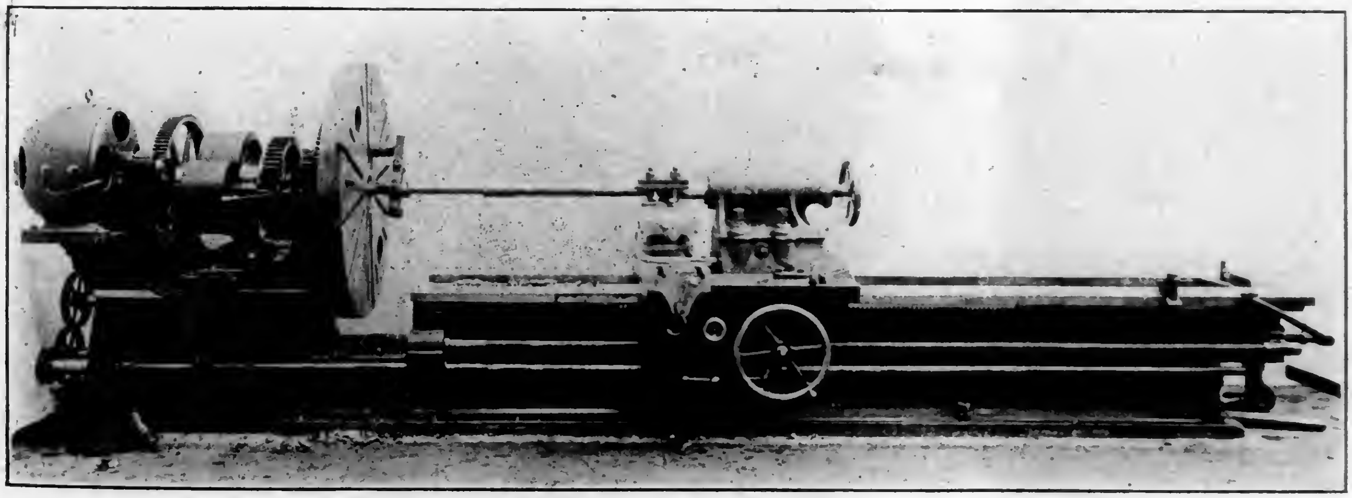
The upper engraving on page 104 illustrates the double-head locomotive-frame slotting machine (tool No. 14), built by Bement, Niles & Co. This tool is driven by a 20-h.p. multiple-voltage motor. The drive is a direct-geared reduction drive from the motor, located at one end of the bed, to the longitudinal splined shaft, which delivers to the two movable heads. These heads are thus independently driven, and they have independent variable-speed feeds, as well as hand, and rapid power, movements along the bed in either direction. This machine has a length of stroke of 21 ins., and a distance between housings of 44¾ ins., with a height under housings of 23 ins.



60-INCH HORIZONTAL BORING AND DRILLING MACHINE.—NILES TOOL WORKS CO. DRIVEN BY A 5-H.P. MULTIPLE-VOLTAGE C.-W. MOTOR.

The 60-in. Niles horizontal boring and drilling machine (tool No. 18) illustrated on this page presents a splendid example of a motor application for the drive. The motor, which is a 5-h.p. multiple-voltage Crocker-Wheeler motor, is mounted upon a bracket bolted to the front side of the frame. The drive is through a double reduction of gearing which is arranged for two changes of speed by slip gears; these speed changes, together with the machine's back gear attachment and also the multiple-voltage system at the motor, provides a wide range of speeds. The spindle of this tool has a 54-in. traverse of two settings, the maximum distance from the center of spindle to the cross table being 23 ins. and to the long table 30 ins. This type of machine furnishes the best known means of quickly and accurately boring a number of parallel holes in work without loosening the clamp-bolts from the table.

The gap lathe illustrated below is the 28-48-in. extension gap lathe (tool No. 35) built by Edwin Harrington, Son & Co., Philadelphia, Pa., and is driven by a 7½-h.p. multiple-voltage Crocker-Wheeler motor. The drive is, on this tool as on the boring machine, through two reductions of gearing which has two speed changes by means of slip gears; in this way the wide range of speed is secured. This gap lathe has particular advantages for the repair shop. As an improvement on the ordinary gap lathe, the extension feature permits making the gap wide or narrow to suit the work; also allows turning a much longer shaft, as the distance between centers may be doubled by extension of top portion of bed. With ample power to turn up to the full diameter of swing over lower bed, it has capacity for a wide range of work and is handy to operate.



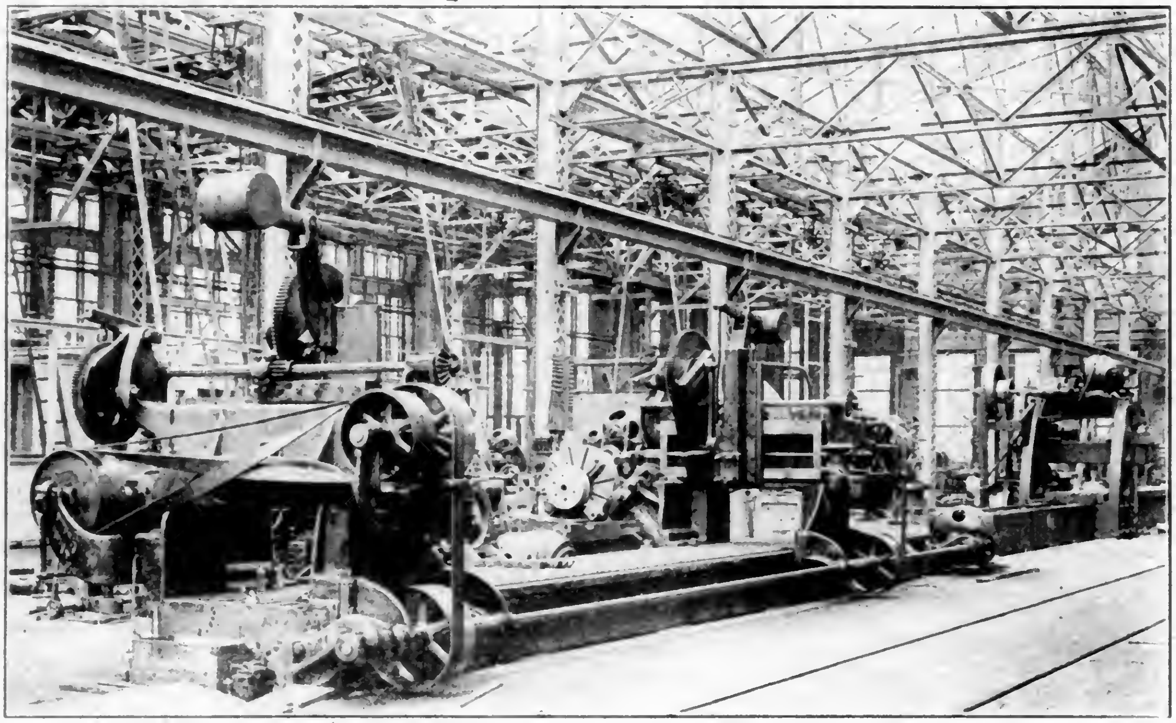
28-INCH—48-INCH EXTENSION GAP LATHE.—EDW. HARRINGTON, SON & CO. DRIVEN BY A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

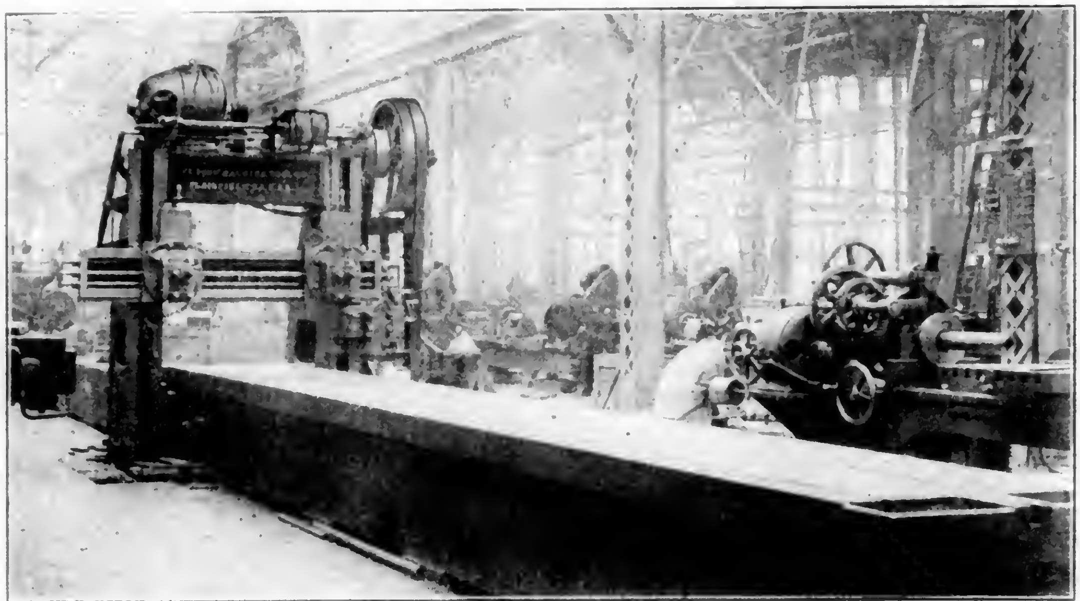
Remarkable progress has been maae in the development of the Cooper-Hewitt electric vapor lamp. The most recent development is the discovery of an application of this vapor tube principle to transforming alternating current to direct current; when alternating current is passed through the lamp only one polarity of the wave is conducted by the vapor, thus effecting a rectification from which a continuous flow of direct current may be drawn.

geared for heavy forge work, the ram being driven by rack and pinion, with tangent gearing at the side. The circular table is 50 ins. in diameter and has 40 ins. longitudinal feed and 36 ins. cross feed, the feeds always taking place at the top of the ram's stroke.

The motor-driven shaper illustrated on page 103 is a 26-in. triple geared shaper of the rack type (tool No. 82) made by the Cincinnati Shaper Company, Cincinnati, Ohio, the motor used for driving it being a 3-h.p. constant-speed Crocker-Wheeler motor. As regularly built for belt drive, the pulleys for the forward and return motions of the ram are placed on the front side of machine; but in order to have the same relative pulley speeds with motor drive as given by belts, the pulley for the reverse or backing motion of ram is placed on front side of the machine, and is driven directly from the fly-wheel on the armature shaft, and the pulley for the cutting or forward motion of the ram is placed at the back and is driven by a pulley on a back shaft, the bearings for which are bolted to the motor frame. The gear on the back shaft runs in mesh with a rawhide pinion attached to the armature shaft, the ratio between the gears and the driving pulleys being such as to give the proper relation between the cutting and reverse speeds of the ram. The design of this shaper involves many interesting features. The head swivels to any angle, being graduated, and is pro



DOUBLE HEAD LOCOMOTIVE FRAME SLOTTING MACHINE.—BEMENT, MILES & CO.—DRIVEN BY A 20-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.
(Heavy 54-inch Frame Planer in background at right.)



HEAVY 54-INCH x 54-INCH x 32-FOOT FRAME PLANER.—POND MACHINE TOOL CO.—SPECIAL FLYWHEEL DRIVE FROM A 20-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.
(Horizontal Boring Machine in background at right.)

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

vided with an automatic down-feed, the screw for which is provided with a graduated collar reading to .001 in. The vise is of a special design in which the fixed jaw extends down to a scraped bearing on the table, thus providing an unusually large footing. Ball bearings are used under the elevating screw for the rail, and also the length of the stroke is very easily changed while the machine is in motion.

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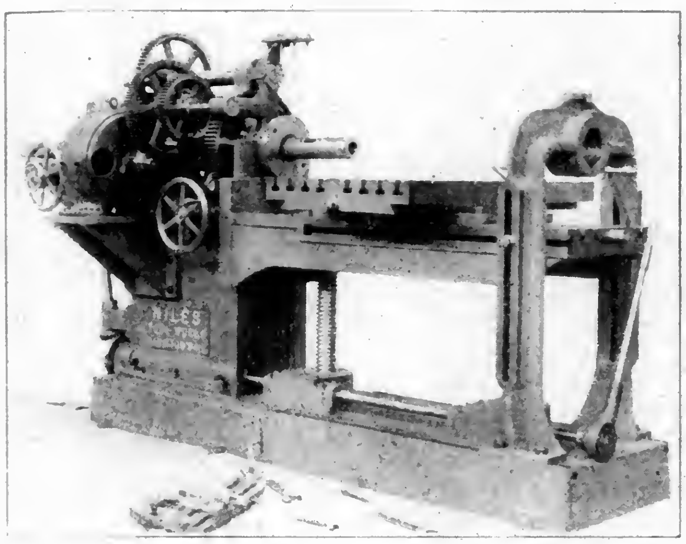

60-INCH HORIZONTAL BORING AND DRILLING MACHINE.—NILES TOOL WORKS CO. DRIVEN BY A 5-H.P. MULTIPLE-VOLTAGE C.-W. MOTOR.

from the motor, located at one end of the bed, to the longitudinal splined shaft, which delivers to the two movable heads. These heads are thus independently driven, and they have independent variable-speed feeds, as well as hand, and rapid power, movements along the bed in either direction. This machine has a length of stroke of 21 ins., and a distance between housings of 11$\frac{3}{4}$ ins., with a height under housings of 23 ins.

The 60-in. Niles horizontal boring and drilling machine (tool No. 18) illustrated on this page presents a splendid example of a motor application for the drive. The motor, which is a 5-h.p. multiple-voltage Crocker-Wheeler motor, is mounted upon a bracket bolted to the front side of the frame. The drive is through a double reduction of gearing which is arranged for two changes of speed by slip gears; these speed changes, together with the machine's back gear attachment and also the multiple-voltage system at the motor, provides a wide range of speeds. The spindle of this tool has a 54-in. traverse of two settings, the maximum distance from the center of spindle to the cross table being 23 ins. and to the long table 30 ins. This type of machine furnishes the best known means of quickly and accurately boring a number of parallel holes in work without loosening the clamp-bolts from the table.

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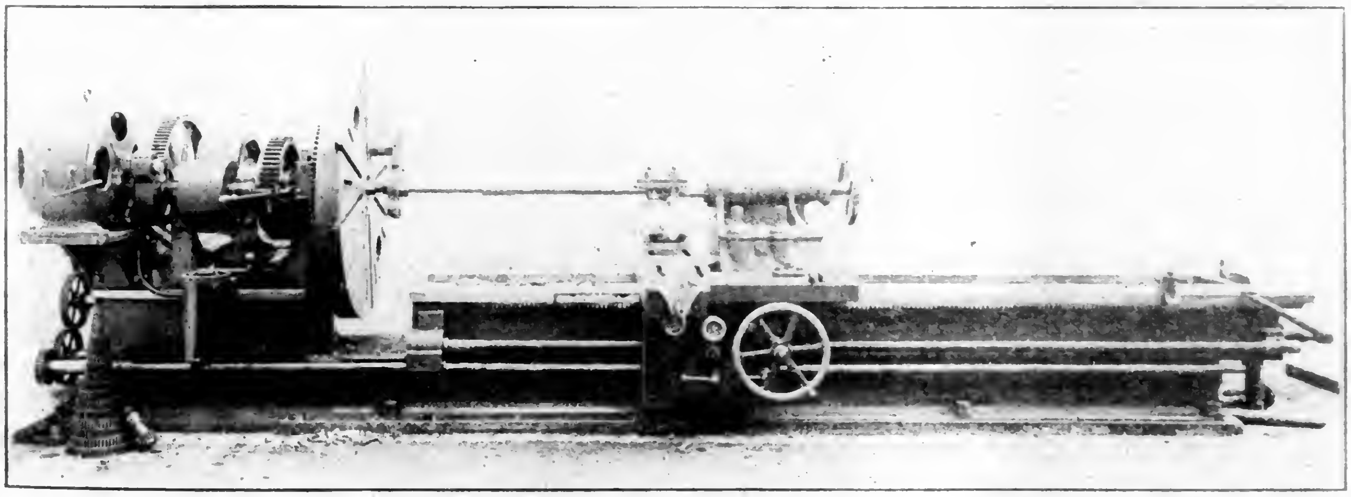

28-INCH—48-INCH EXTENSION GAP LATHE.—EDW. HARRINGTON, SON & CO. DRIVEN BY A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

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power to turn up to the full diameter of swing over lower bed, it has capacity for a wide range of work and is handy to operate.

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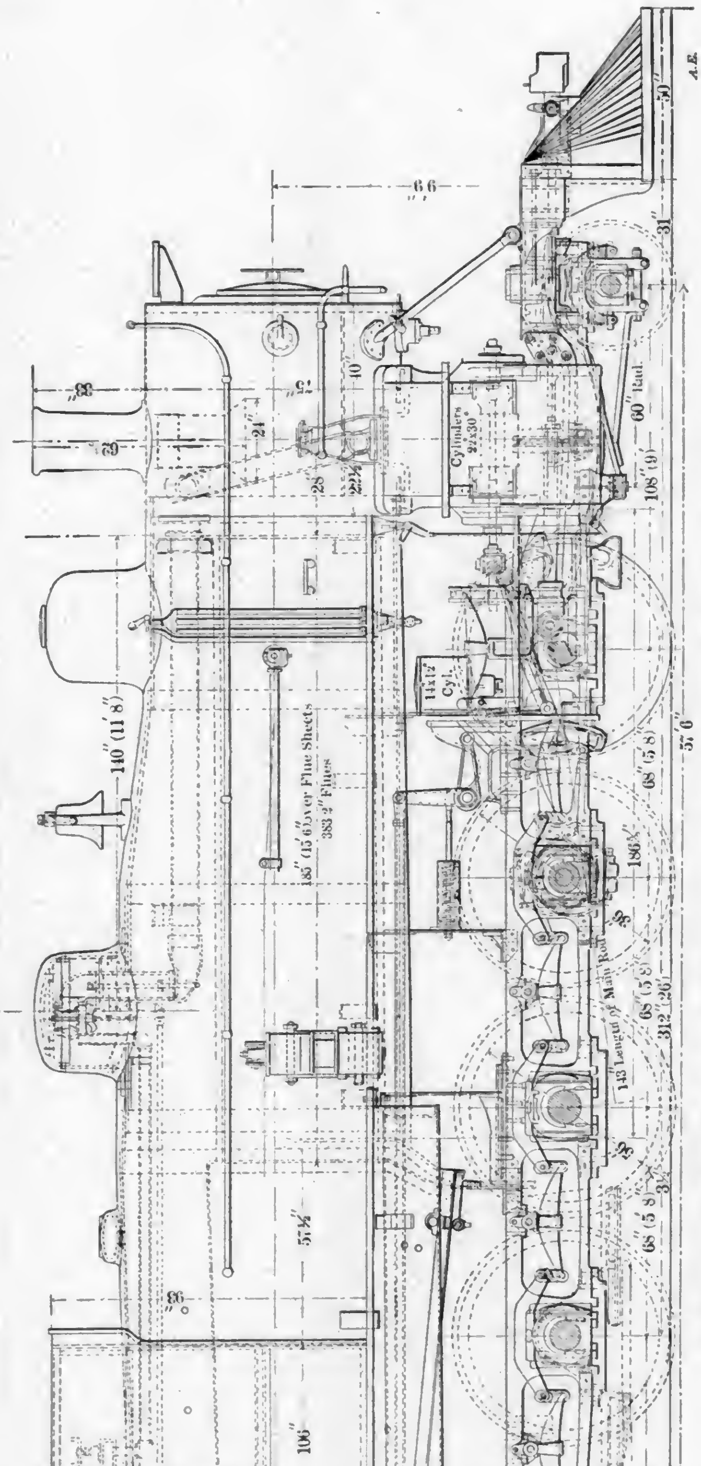


FREIGHT LOCOMOTIVE.—2—8—0 TYPE.—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.
BUILT BY AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS.

FREIGHT LOCOMOTIVES.

2—8—0 TYPE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

These drawings and photograph illustrate an order of 135 heavy freight locomotives now being built for this road at the Brooks Works of the American Locomotive Company. The weights are a little less than those of the Burlington engine, illustrated last month, and so also is the heating surface. The extent of the order and the fact that this is the most powerful engine thus far used on the Rock Island confirm the observation made last month to the effect that there is a systematic tendency toward a marked but gradual increase in power of freight locomotives. These engines form a part of an order of 225 placed last year by this road with the American Locomotive Company.

Among the details the valve gear and frame construction are specially interesting. The valves are of the inside admission type and the clearances are unusually small, as the sectional engraving shows. This drawing also illustrates the direct or straight-line construction of the motion bar with reference to the jaws at its ends, and the same idea is carried out in the crosshead attachment to the valve stem. The rocker box furnishes a long bearing for the rocker, which is a substantial steel casting. This is a development to which special attention has been given for several years in the designs by the Brooks Works.

The frames are in a single piece, with no splices, and they are of cast steel, 5 ins. wide. These works have taken advantage of the fact that cast-steel frames are easily made in one piece. At their front ends the frames stop immediately in front of the cylinders, where they are bolted to a large steel casting forming the front deck and spindle guide in one piece. This construction is shown in the elevation drawing and also in the detail drawing of the frames.

RATIOS.

Tractive effort	39,000 lbs.
Heating surface to cylinder volume	247.3
Adhesive weight to heating surface	55.14
Adhesive weight to tractive effort	4.61
Tractive effort to heating surface	11.94
Heating surface to grate area	65.28
Tractive effort × diameter of drivers to heating surface	752.2
Heating surface to tractive effort	8.36%
Total weight to heating surface	61.4

FREIGHT LOCOMOTIVE, 2—8—0 TYPE.

Chicago, Rock Island & Pacific Railway.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	200,500 lbs.
Weight on drivers	180,000 lbs.
Weight engine and tender in working order	345,000 lbs.
Wheel base, driving	17 ft.
Wheel base, rigid	17 ft.
Wheel base, total	26 ft.
Wheel base, total, engine and tender	57 ft. 6 ins.

Cylinders.

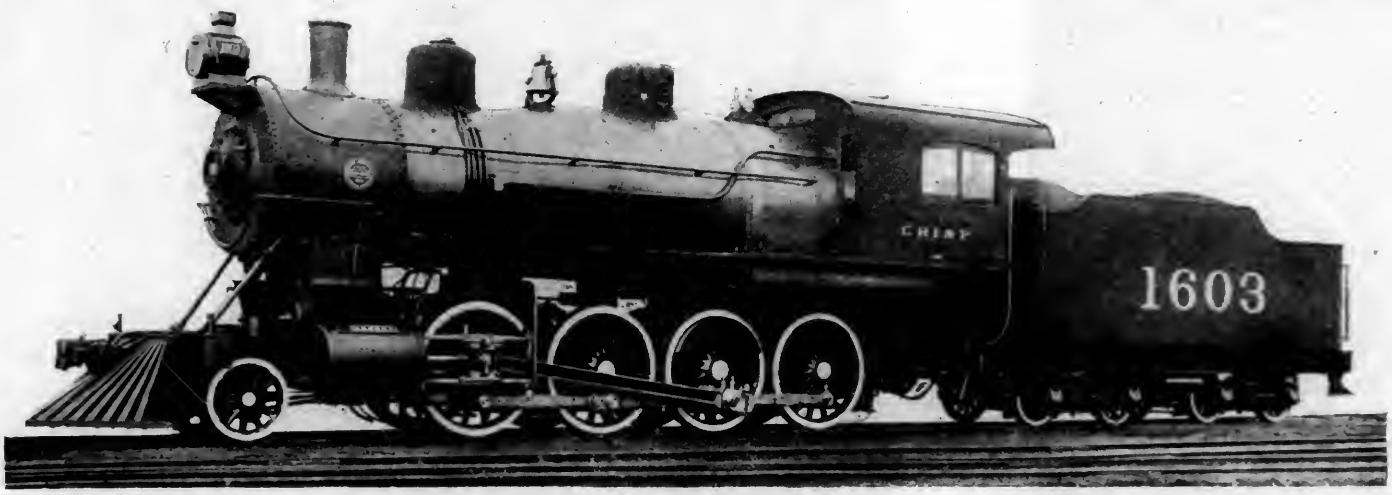
Diameter of cylinders	22 ins.
Stroke of piston	30 ins.
Horizontal thickness of piston	21 61-64 ins.
Diameter of piston rod	4 ins.
Kind of piston-rod packing	U. S.
Size of steam ports	2 ins. x 29 ins.
Size of exhaust ports	Area, 65 sq. ins.
Size of bridges	2 13-16 ins.

Valves.

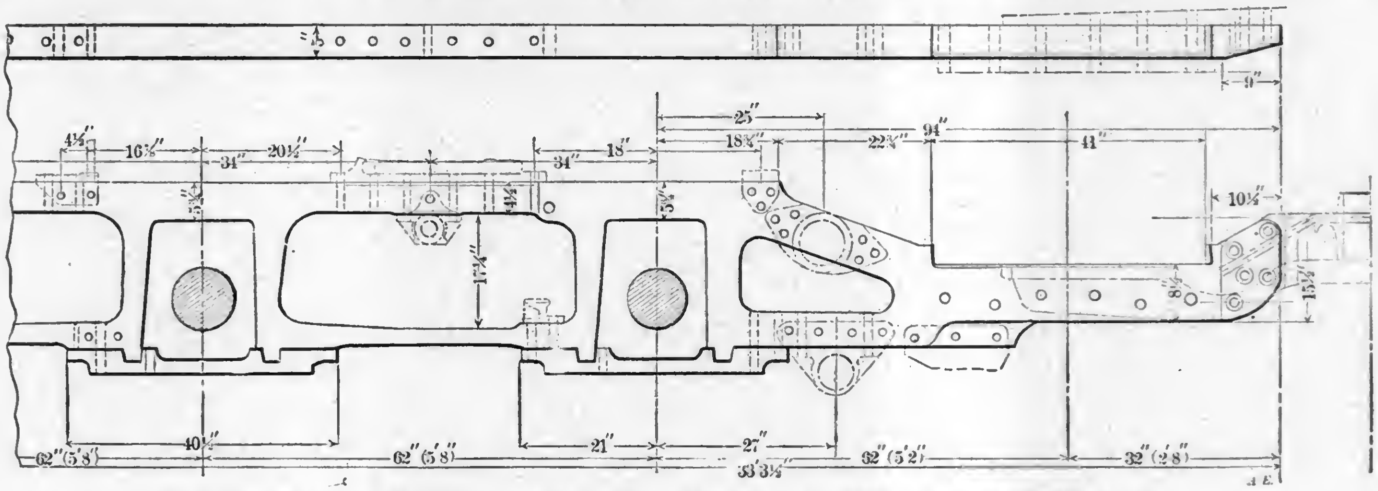
Kind of valves	Improved piston
Greatest travel of valves	5 13-16 ins.
Outside lap of valves	1 in.
Inside lap of valves	0 in.
Lead of valves in full gear	—3-32 in

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	63 ins.
Material of driving wheel centers	Cast steel
Thickness of tire	3½ ins.
Driving box material	Cast steel
Diameter and length of driving journals: Main, 10 ins. diameter by 12 ins.; others, 9 ins. diameter by 12 ins.	
Diameter and length of main crankpin journals	7 ins. diameter by 7 ins.
Diameter and length of side-rod crankpin journals	7½ ins. diameter by 5 ins.
Engine truck, kind	Radial and swing
Engine truck journals	6 ins. diameter by 12 ins.
Diameter of engine truck wheels	36 ins.



2—8—0 TYPE FREIGHT LOCOMOTIVE.—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.



CAST STEEL FRAMES—SHOWING CONSTRUCTION AT FRONT END AND ATTACHMENT TO SPINDLE GUIDE CASTING.

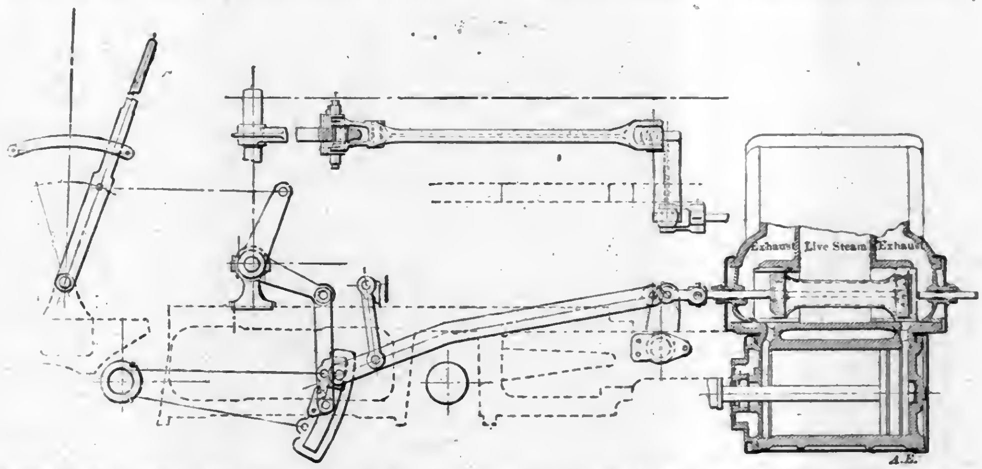


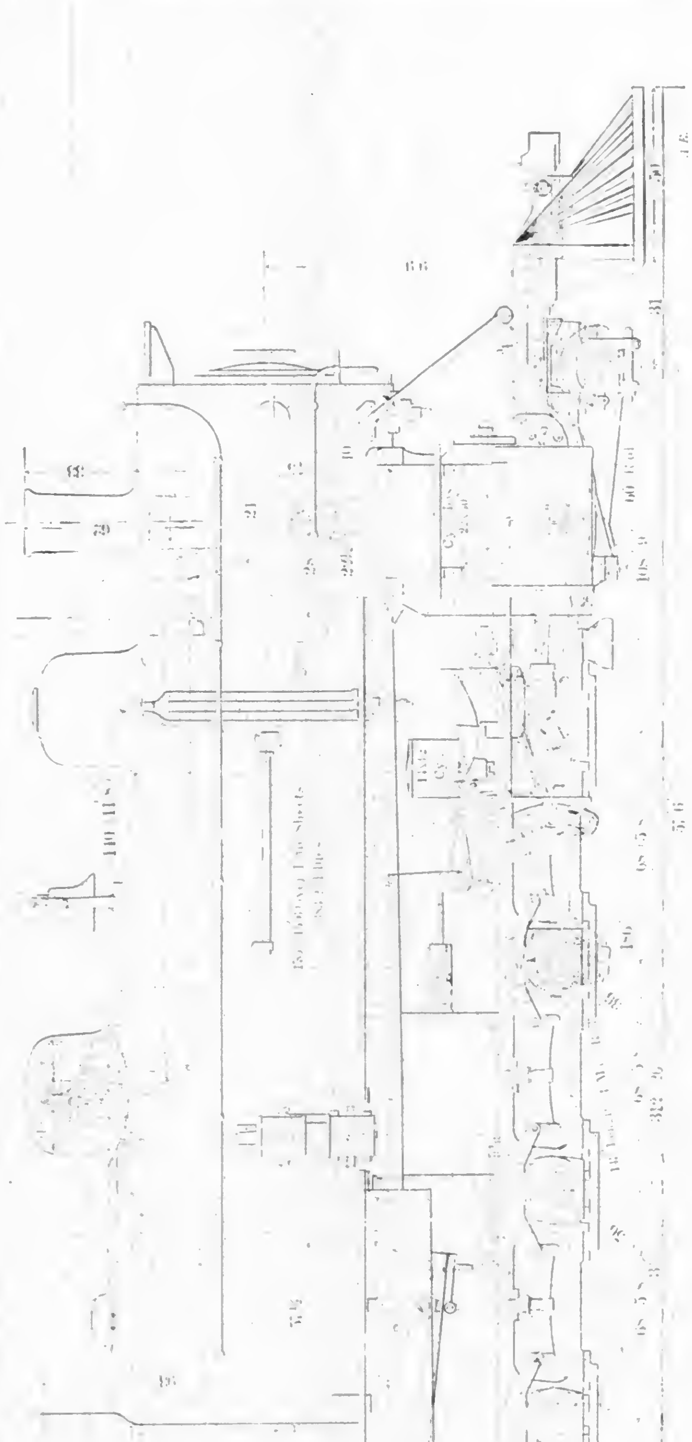
DIAGRAM OF VALVE MOTION.—THIS ARRANGEMENT GIVES A CLEARANCE OF 6.84 PER CENT., INCLUDING CYLINDER CLEARANCE, PORTS AND SPACE AROUND VALVE AND BUSHING.

Boiler.

Style	Radial stayed and extended wagon top
Outside diameter of first ring	72⅛ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox:	¾, 25-32, 13-16, 9-16, ½, ¾ in.
Firebox, length	108 ins
Firebox, width	68 ins.
Firebox, depth	Front, 75½ ins.; back, 61½ ins.
Firebox plates, thickness:	Sides, ⅜; back, ⅜; crown, ⅜; tube sheet, ⅝
Firebox, water space	Front, 4 ins.; sides, 4 ins.; back, 4 ins.
Firebox, crown staying	1 in.
Firebox, stay bolts	1 in.
Tubes, number	383
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft. 6 ins.
Heating surface, tubes	3,087 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	3,264 sq. ft.
Grate surface	50 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5½ ins. diameter
Smokestack, inside diameter	16¾—15 ins.
Smokestack, top above rail	15 ft. 7½ ins.

Tender.

Style	Eight wheel
Weight, empty	57,220 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter by 10 ins.
Wheel base	18 ft.
Tender frame	13-in. channel
Water capacity	7,000 U. S. gals.
Coal capacity	15 tons



FREIGHT LOCOMOTIVE—2—8—0 TYPE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

BUILT BY AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS.

FREIGHT LOCOMOTIVES.

2—8—0 TYPE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

These drawings and photograph illustrate an order of 135 heavy freight locomotives now being built for this road at the Brooks Works of the American Locomotive Company. The weights are a little less than those of the Burlington engine, illustrated last month, and so also is the heating surface. The extent of the order and the fact that this is the most powerful engine thus far used on the Rock Island confirm the observation made last month to the effect that there is a systematic tendency toward a marked but gradual increase in power of freight locomotives. These engines form a part of an order of 225 placed last year by this road with the American Locomotive Company.

Among the details the valve gear and frame construction are specially interesting. The valves are of the inside admission type and the clearances are unusually small, as the sectional engraving shows. This drawing also illustrates the direct or straight-line construction of the motion bar with reference to the jaws at its ends, and the same idea is carried out in the crosshead attachment to the valve stem. The rocker box furnishes a long bearing for the rocker, which is a substantial steel casting. This is a development to which special attention has been given for several years in the designs by the Brooks Works.

The frames are in a single piece, with no splices, and they are of cast steel, 5 ins. wide. These works have taken advantage of the fact that cast-steel frames are easily made in one piece. At their front ends the frames stop immediately in front of the cylinders, where they are bolted to a large steel casting forming the front deck and spindle guide in one piece. This construction is shown in the elevation drawing and also in the detail drawing of the frames.

RATIOS.

Tractive effort	39,000 lbs.
Heating surface to cylinder volume	247.3
Adhesive weight to heating surface	55.14
Adhesive weight to tractive effort	4.61
Tractive effort to heating surface	11.91
Heating surface to grate area	65.28
Tractive effort × diameter of drivers to heating surface	752.2
Heating surface to tractive effort	8.367
Total weight to heating surface	61.4

FREIGHT LOCOMOTIVE, 2—8—0 TYPE.

Chicago, Rock Island & Pacific Railway.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	200,500 lbs.
Weight on drivers	180,000 lbs.
Weight engine and tender in working order	345,000 lbs.
Wheel base, driving	17 ft.
Wheel base, rigid	17 ft.
Wheel base, total	26 ft.
Wheel base, total, engine and tender	57 ft. 6 ins.

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	30 ins.
Horizontal thickness of piston	21 61-64 ins.
Diameter of piston rod	4 ins.
Kind of piston rod packing	U. S.
Size of steam ports	2 ins. x 29 ins.
Size of exhaust ports	Area, 65 sq. ins.
Size of bridges	2 13-16 ins.

Valves.

Kind of valves	Improved piston
Greatest travel of valves	5 13-16 ins.
Outside lap of valves	1 in.
Inside lap of valves	0 in.
Lead of valves in full gear	3-32 in.

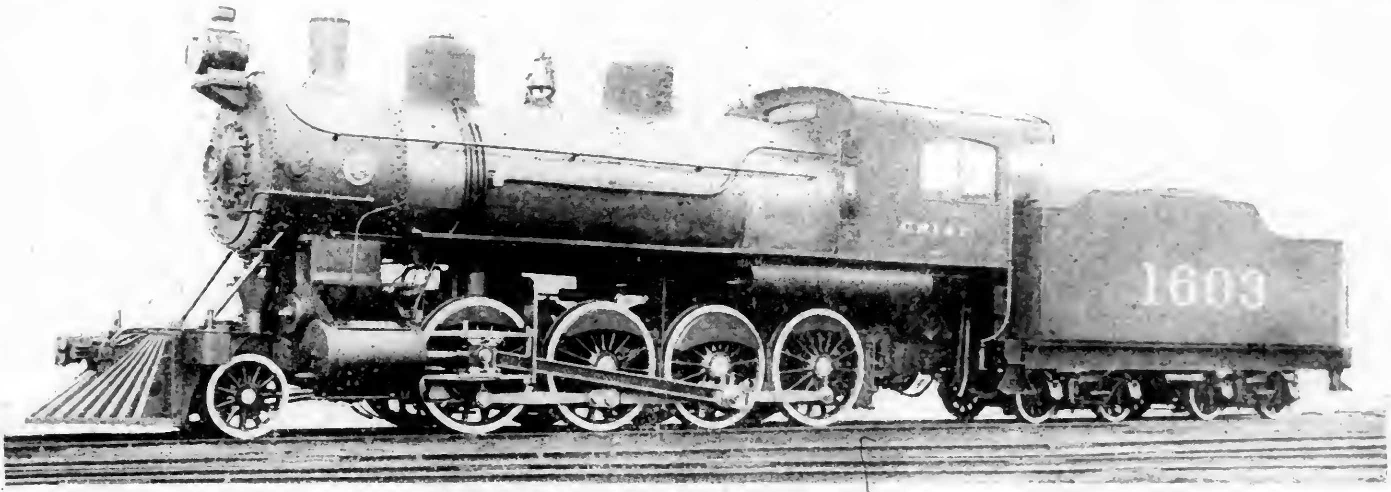
Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	63 ins.
Material of driving wheel centers	Cast steel
Thickness of tire	3½ ins.
Driving box material	Cast steel

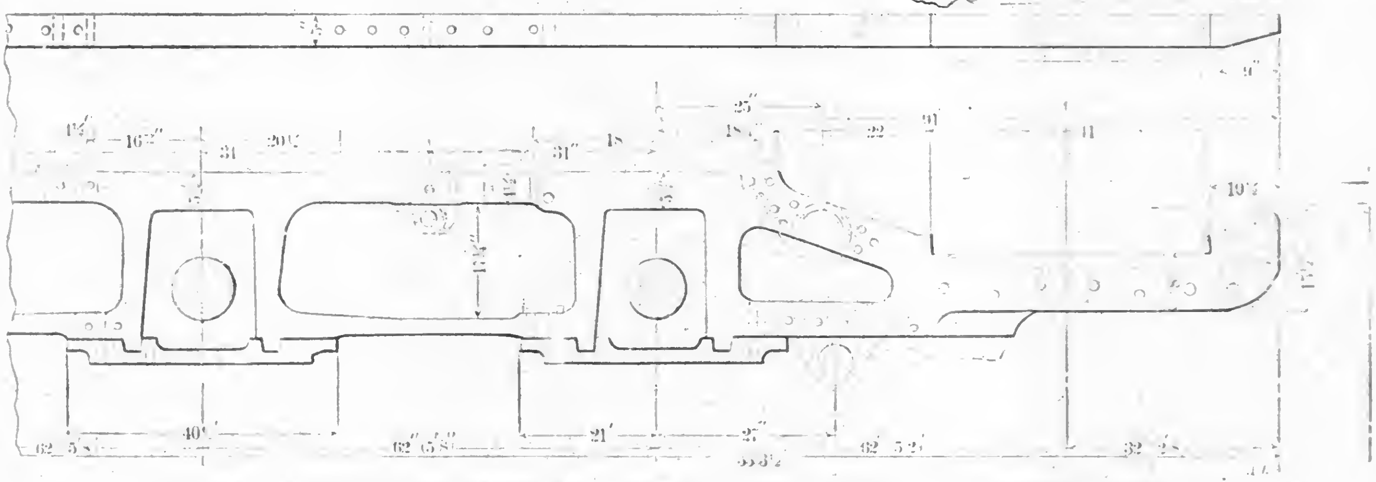
Diameter and length of driving journals:

Main, 10 ins. diameter by 12 ins.; others, 9 ins. diameter by 12 ins.

Diameter and length of main crankpin journals	7 ins. diameter by 7 ins.
Diameter and length of side-rod crankpin journals	7½ ins. diameter by 5 ins.
Engine truck, kind	Radial and swing
Engine truck journals	6 ins. diameter by 12 ins.
Diameter of engine truck wheels	36 ins.



2—8—0 TYPE FREIGHT LOCOMOTIVE.—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.



CAST STEEL FRAMES, SHOWING CONSTRUCTION AT FRONT END AND ATTACHMENT TO SPINDLE GUIDE CASTING.

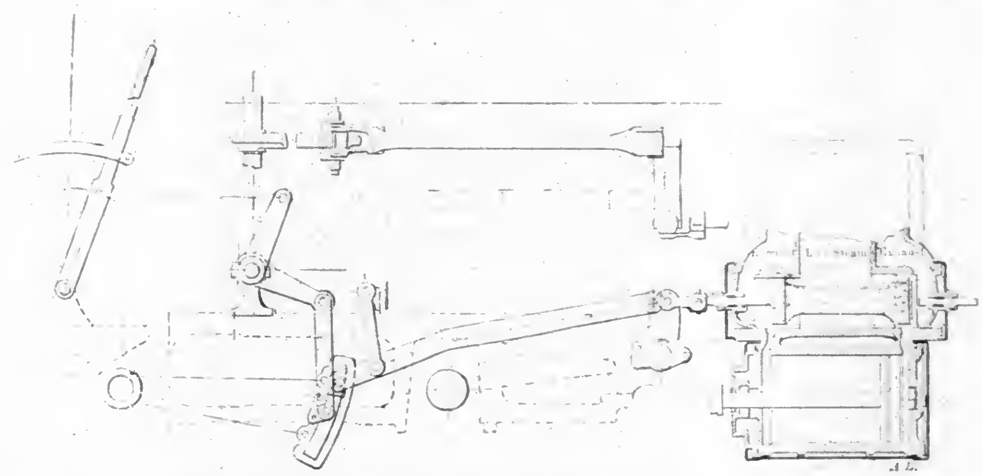


DIAGRAM OF VALVE MOTION.—THIS ARRANGEMENT GIVES A CLEARANCE OF 6.8 PER CENT., INCLUDING CYLINDER CLEARANCE, PORTS AND SPACE AROUND VALVE AND BUSHING

Boiler.

Style	Radial stayed and extended wagon top
Outside diameter of first ring	72⅛ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	¾, 25-32, 13-16, 9-16, ½, ⅜ in.
Firebox, length	108 ins
Firebox, width	68 ins.
Firebox, depth	Front, 75½ ins.; back, 61½ ins.
Firebox plates, thickness	Sides, ⅜; back, ⅜; crown, ⅜; tube sheet, ⅝
Firebox, water space	Front, 4 ins.; sides, 4 ins.; back, 4 ins.
Firebox, crown staying	1 in.
Firebox, stay bolts	1 in.
Tubes, number	383
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Tubes, length over tube sheets	15 ft. 6 ins.
Heating surface, tubes	3,087 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	3,264 sq. ft.
Grate surface	50 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5½ ins. diameter
Smokestack, inside diameter	16¾—15 ins.
Smokestack, top above rail	15 ft. 7½ ins.

Tender.

Style	Eight wheel
Weight, empty	57,220 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter by 10 ins.
Wheel base	18 ft.
Tender frame	13-in. channel
Water capacity	7,000 U. S. gals.
Coal capacity	15 tons

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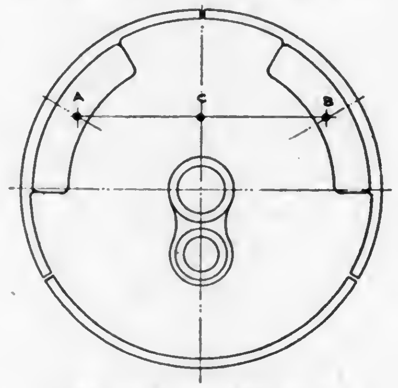

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2—8—2 (MIKADO) TYPE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

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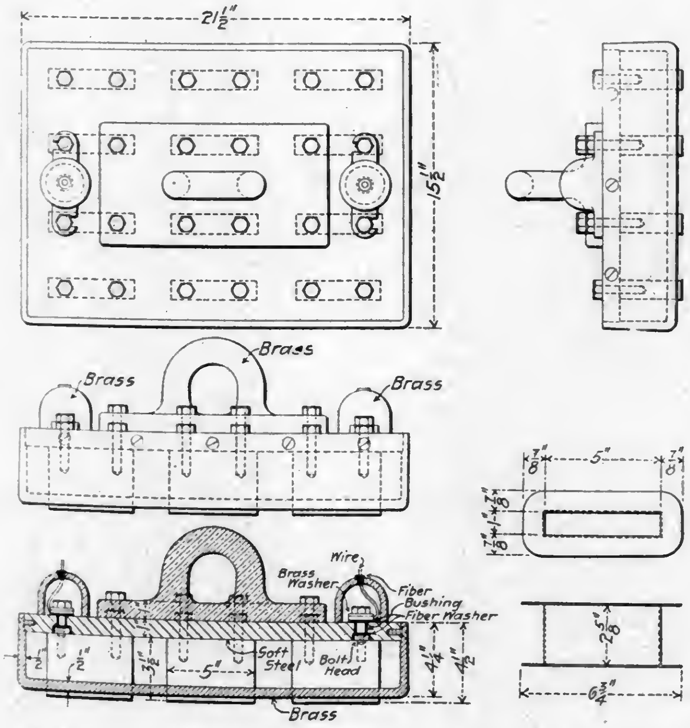

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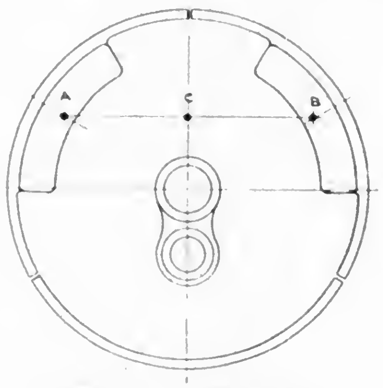

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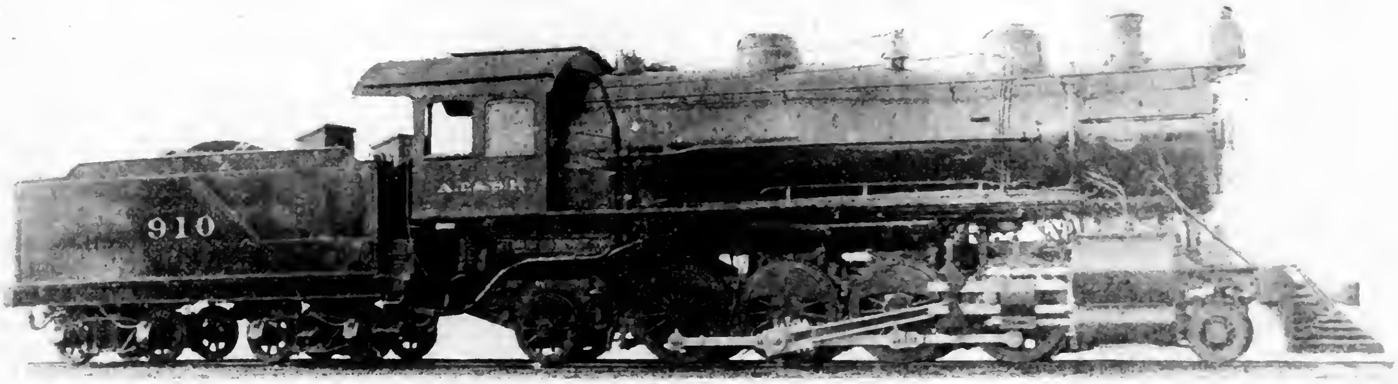

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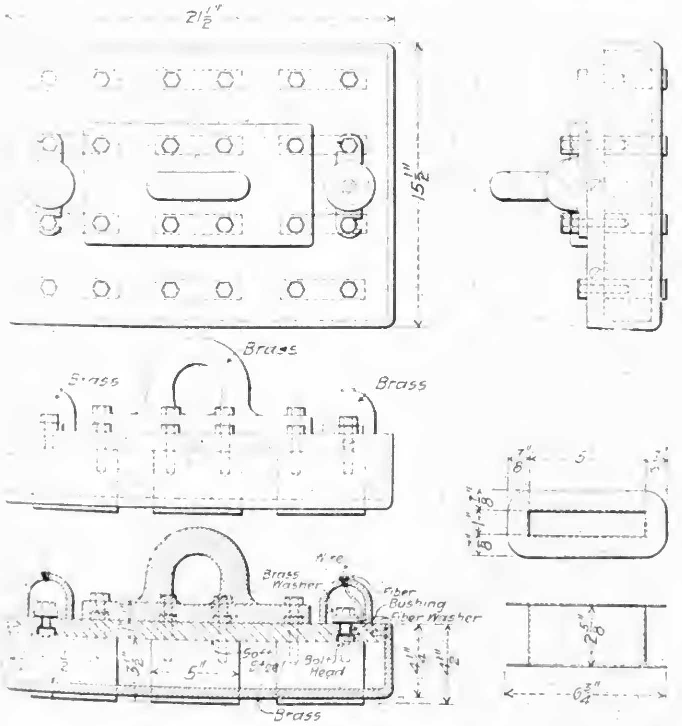

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A REMARKABLE MACHINING PERFORMANCE WITH A MOTOR-DRIVEN TOOL.

An interesting machining performance was recently made with a large motor-driven boring mill at the shops of the Bullock Electric Company at Cincinnati, Ohio, which serves to demonstrate the true value of the electrical method of tool driving. The tool in use was a 12-foot Niles boring mill, direct-driven by a Bullock standard type N multiple-voltage motor, rated at 15 h.p. at a speed of 500 revolutions per minute. This motor is located within the protecting boxing shown at the left of the frame in the accompanying illustration, the motor shown on top of the frame of the tool being used exclusively for adjusting the cross rail.

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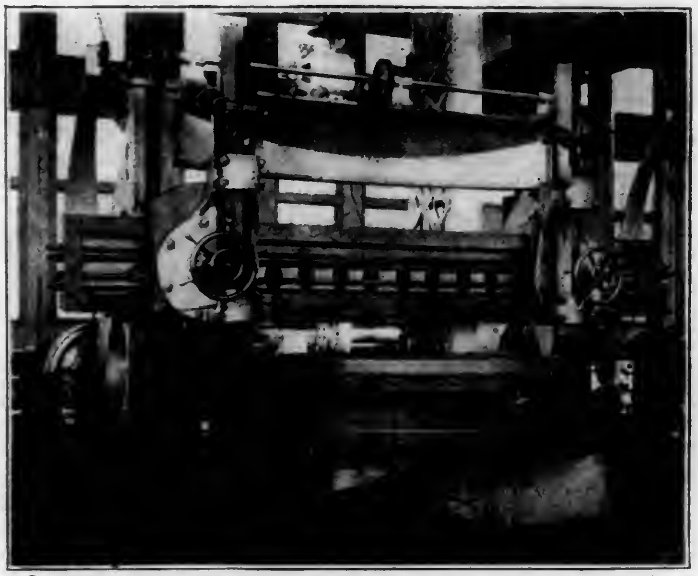


VIEW OF THE BORING MILL USED IN TURNING THE COMMUTATOR SLEEVES —BULLOCK ELECTRIC MFG. CO.

The castings were of medium hard iron, and the tool steel used was the Firth-Sterling air-hardening tool steel. Both heads were used, one tool in each, the table revolving for a cutting speed of 60 ft. per minute. The depth of cut at either tool varied from ¾ to ⅞ in., due to the usual inequalities of surface of castings, and the feed was ⅛ in. at each tool, which corresponds to a feed of ¼ in. per revolution of the table if only a single tool were used.

Under this feed the metal was removed at the rate of 1,200 lbs. of chips per hour. Careful measurements were made of the power required for driving the machines under these conditions, which showed the gross input at the motor, measured electrically, to be ¼ h.p. for each cubic inch of metal removed—a very economical performance. The adaptability of the multiple voltage system cannot be better illustrated than by this operation; with the controller used on this machine, giving 26 different speeds, it was extremely easy to satisfactorily adjust the cutting speed to the capacity of the tool steel used, as a result of which this high cutting rate was obtained.

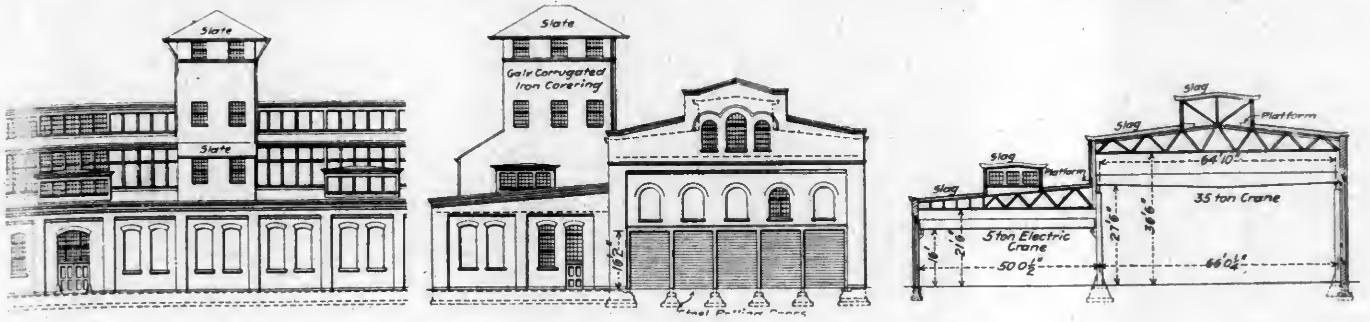
Another interesting result was recently shown at the Bullock Company's works in a comparison of machining operations. A power input test, similar to the above-described test upon the boring mill, was made upon a motor-driven rotary planer which was being operated at a high cutting rate planing cast iron. The tool was a Pond rotary planer with a 50-in. head having 60 inserted cutters, and was driven at a feed of ⅝ in. per revolution of the head, which is equivalent to a feed of a trifle over .01 in. per cutter. The amount of metal removed at this cutting rate was 1,200 lbs. per hour (20 lbs. per minute). Measurements of the power required to drive the tool showed a power input at the motor of 15 h.p.; from this it is evident that with 20 lbs. of chips removed per minute with 15 h.p., ¾ h.p. is required per pound of metal removed—an expenditure of three times as much power as was required upon the boring-mill operation.

While the actual expenditure of power per cubic inch of metal removed is of minor importance as compared with the time required for an operation in most cases, still the discrepancy in power required by the rotary planer is here very significant. It illustrates in the most forcible manner possible the effect of the multiple inserted cutter tool: with each cutter of the head having an individual feed of .01 in. the metal removed is very finely broken up—almost pulverized—while with the boring mill using only two cutting tools under very heavy feeds the metal is broken up into chips of coarser size. The rotary planer operation would naturally require more power, but it is interesting to note that it required three times as much power as the boring mill operation per unit of metal removed for that reason.

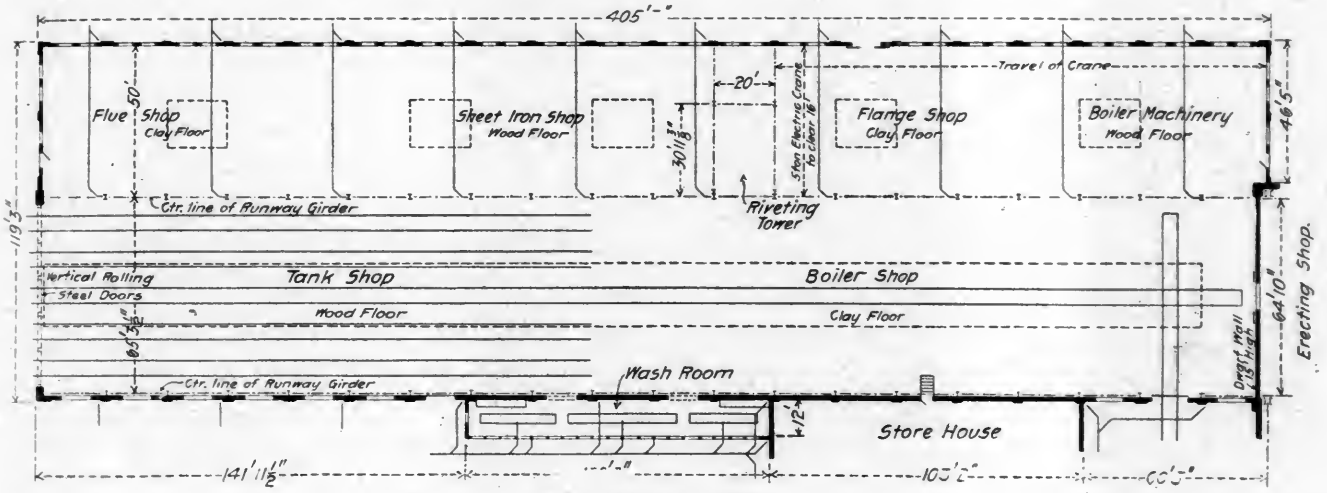
Mr. Alexander C. Humphreys was inaugurated president of the Stevens Institute of Technology at Hoboken February 5, succeeding the late president, Henry Morton, who held the office from the founding of the institute in 1870 until his death last year. President Humphreys was born in Scotland in 1851, and came to this country while a young man. After spending a number of years in business and rising to the position of secretary of the Bayonne and Greenville Gas Light Company, he arranged to study at Stevens Institute, and by employing his evenings and spare time, completed his course to graduation in 1881. He then became chief engineer of the Pintsch Lighting Company and remained until 1894, when he turned his attention to business in the firm of Humphreys & Glasgow. He has had a prominent part in constructing gas and electric lighting plants and in their management and the business interests connected with them. Coming as he does from a successful business experience, and being an energetic, forceful man, he is unusually well qualified to succeed to this important office. The many friends of Stevens Institute, as well as its nearly one thousand graduates, look forward to his administration with confidence and expectation of continued progress.

Mr. R. J. Gross, second vice-president of the American Locomotive Company, Dunkirk, N. Y., has started on a trip around the world. He goes by way of San Francisco, the first stop to be at Honolulu. From there he goes to Japan, Korea and Siam, and from China he will travel over the Trans-Siberian Railroad to Russia. He plans to visit every country in Europe. Mr. Gross will be absent from this country about a year. The purpose of his trip is to make a careful investigation of the opportunities for American locomotives in the Orient and European countries and to establish systematic business relations. Mr. Gross will be accompanied on his trip by Charles M. Muchnic, until recently mechanical engineer of the Denver & Rio Grande, who will act as Mr. Gross' secretary.

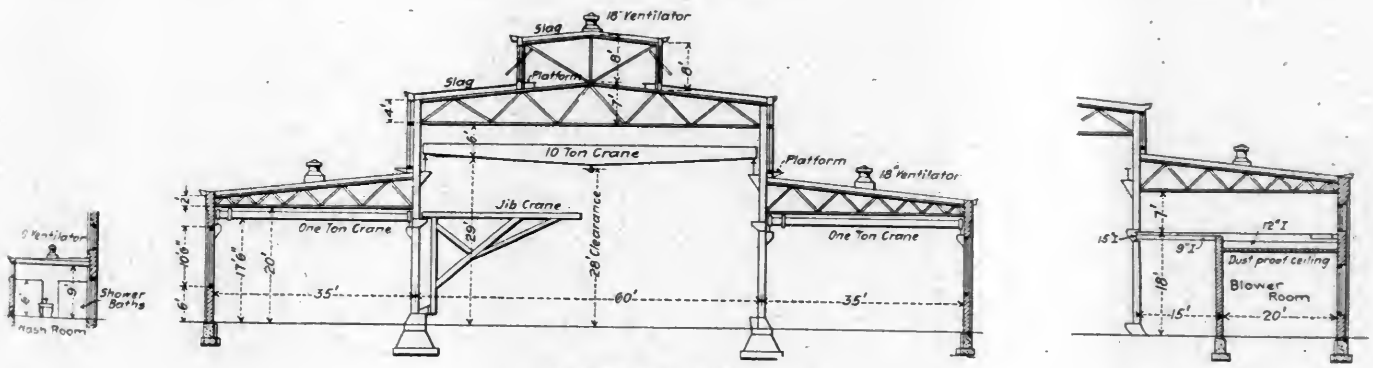
Mr. Max Toltz has resigned as mechanical engineer of the Great Northern Railway. He is engaged in superintending the application of his system of acetylene car lighting to a large number of cars on the Canadian Pacific, and has been retained by that road in a consulting engineering capacity in connection with the new shops at Montreal.



PARTIAL SIDE ELEVATION, END ELEVATION AND SECTION OF BOILER SHOP.



PLAN OF BOILER SHOP.



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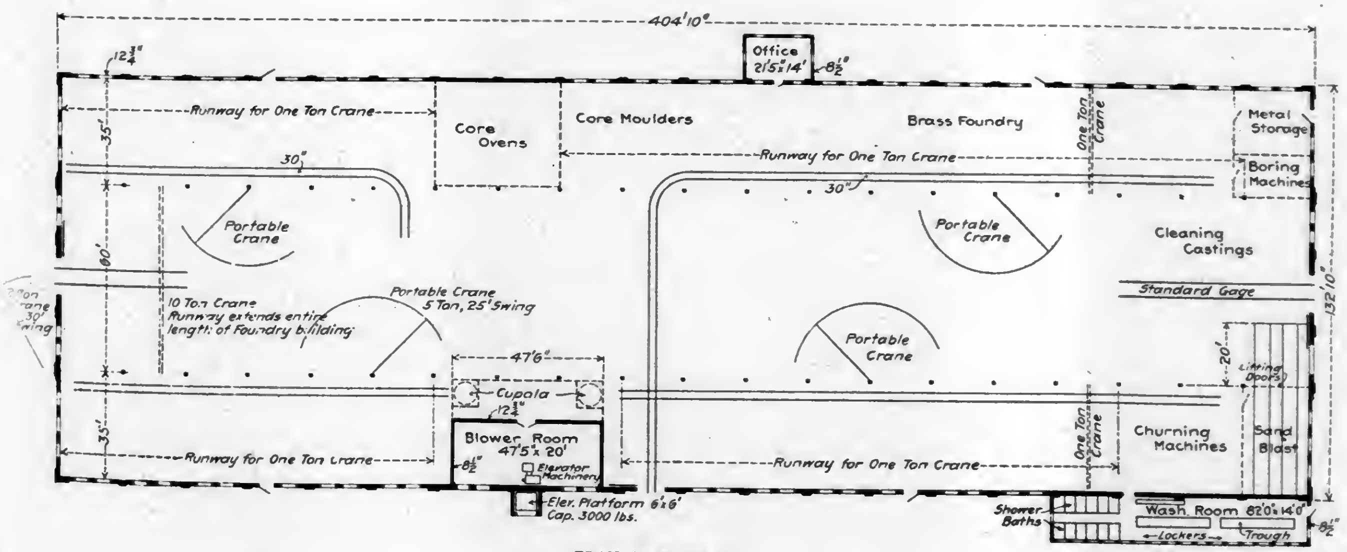

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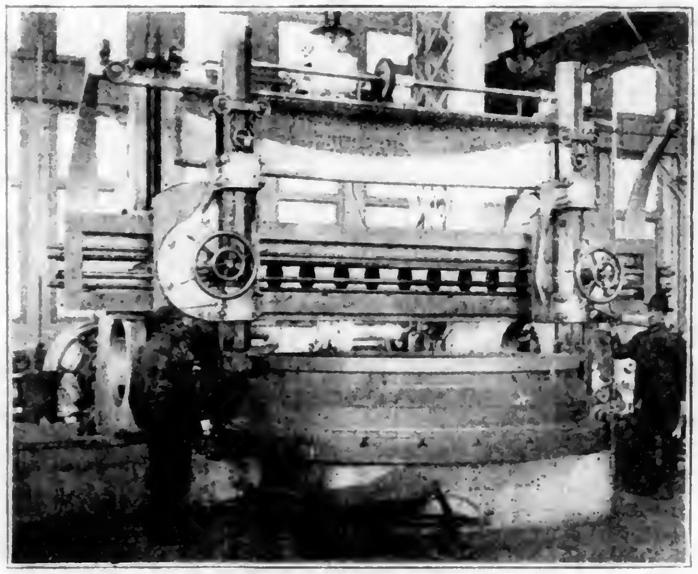


VIEW OF THE BORING MILL USED IN TURNING THE COMMUTATOR SLEEVES BULLOCK ELECTRIC MFG. CO.

The castings were of medium hard iron, and the tool steel used was the Firth-Sterling air-hardening tool steel. Both heads were used, one tool in each, the table revolving for a cutting speed of 60 ft. per minute. The depth of cut at either tool varied from $\frac{3}{4}$ to $\frac{7}{8}$ in., due to the usual inequatities of surface of castings, and the feed was $\frac{1}{8}$ in. at each tool, which corresponds to a feed of $\frac{1}{4}$ in. per revolution of the table if only a single tool were used.

Under this feed the metal was removed at the rate of 1,200 lbs. of chips per hour. Careful measurements were made of the power required for driving the machines under these conditions, which showed the gross input at the motor, measured electrically, to be $\frac{1}{4}$ h.p. for each cubic inch of metal removed—a very economical performance. The adaptability of the multiple voltage system cannot be better illustrated than by this operation; with the controller used on this machine, giving 26 different speeds, it was extremely easy to satisfactorily adjust the cutting speed to the capacity of the tool steel used, as a result of which this high cutting rate was obtained.

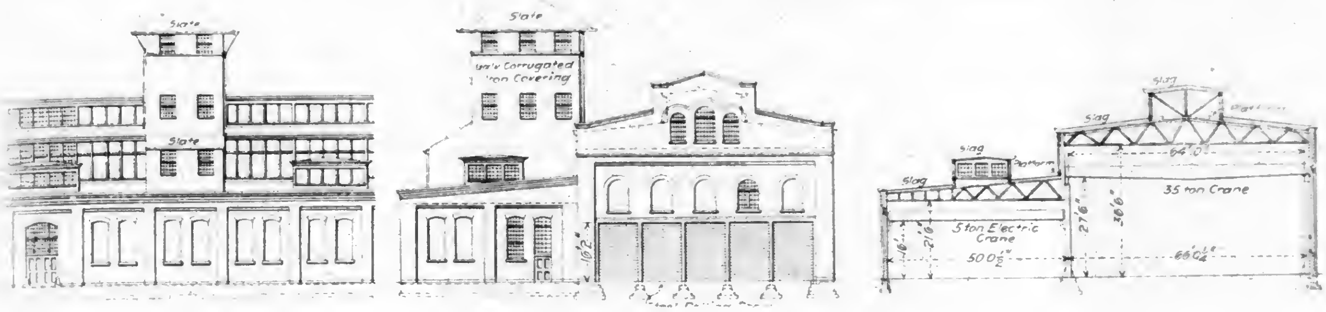
Another interesting result was recently shown at the Bullock Company's works in a comparison of machining operations. A power input test, similar to the above-described test upon the boring mill, was made upon a motor-driven rotary planer which was being operated at a high cutting rate planing cast iron. The tool was a Pond rotary planer with a 50-in. head having 60 inserted cutters, and was driven at a feed of $\frac{5}{8}$ in. per revolution of the head, which is equivalent to a feed of a trifle over .01 in. per cutter. The amount of metal removed at this cutting rate was 1,200 lbs. per hour (20 lbs. per minute). Measurements of the power required to drive the tool showed a power input at the motor of 15 h.p.; from this it is evident that with 20 lbs. of chips removed per minute with 15 h.p., $\frac{3}{4}$ h.p. is required per pound of metal removed—an expenditure of three times as much power as was required upon the boring-mill operation.

While the actual expenditure of power per cubic inch of metal removed is of minor importance as compared with the time required for an operation in most cases, still the discrepancy in power required by the rotary planer is here very significant. It illustrates in the most forcible manner possible the effect of the multiple inserted cutter tool: with each cutter of the head having an individual feed of .01 in. the metal removed is very finely broken up—almost pulverized—while with the boring mill using only two cutting tools under very heavy feeds the metal is broken up into chips of coarser size. The rotary planer operation would naturally require more power, but it is interesting to note that it required three times as much power as the boring mill operation per unit of metal removed for that reason.

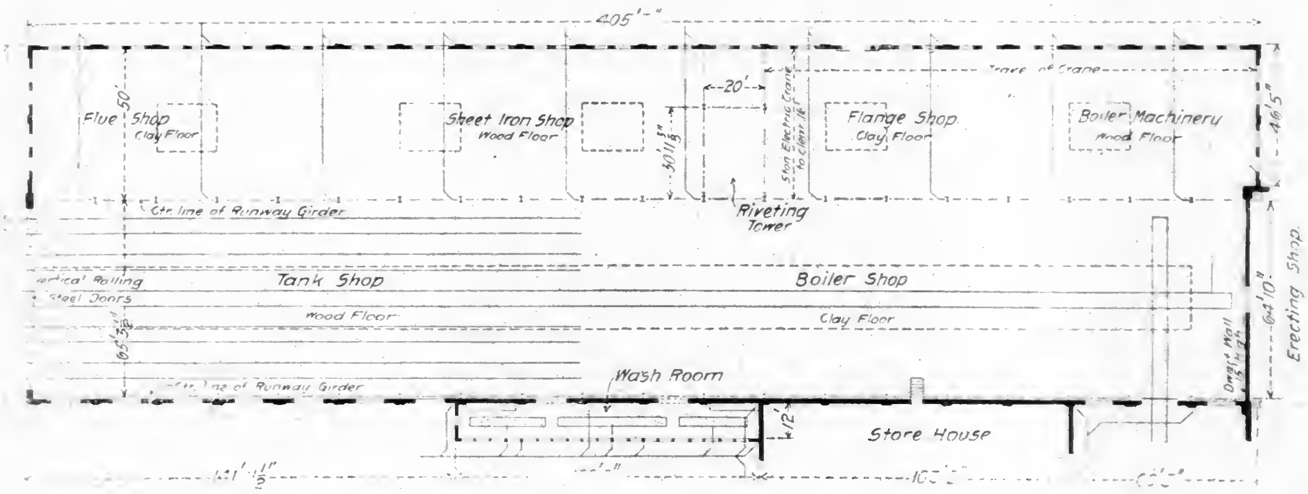
Mr. Alexander C. Humphreys was inaugurated president of the Stevens Institute of Technology at Hoboken February 5, succeeding the late president, Henry Morton, who held the office from the founding of the institute in 1870 until his death last year. President Humphreys was born in Scotland in 1851, and came to this country while a young man. After spending a number of years in business and rising to the position of secretary of the Bayonne and Greenville Gas Light Company, he arranged to study at Stevens Institute, and by employing his evenings and spare time, completed his course to graduation in 1881. He then became chief engineer of the Pintsch Lighting Company and remained until 1894, when he turned his attention to business in the firm of Humphreys & Glasgow. He has had a prominent part in constructing gas and electric lighting plants and in their management and the business interests connected with them. Coming as he does from a successful business experience, and being an energetic, forceful man, he is unusually well qualified to succeed to this important office. The many friends of Stevens Institute, as well as its nearly one thousand graduates, look forward to his administration with confidence and expectation of continued progress.

Mr. R. J. Gross, second vice-president of the American Locomotive Company, Dunkirk, N. Y., has started on a trip around the world. He goes by way of San Francisco, the first stop to be at Honolulu. From there he goes to Japan, Korea and Siam, and from China he will travel over the Trans-Siberian Railroad to Russia. He plans to visit every country in Europe. Mr. Gross will be absent from this country about a year. The purpose of his trip is to make a careful investigation of the opportunities for American locomotives in the Orient and European countries and to establish systematic business relations. Mr. Gross will be accompanied on his trip by Charles M. Muchnic, until recently mechanical engineer of the Denver & Rio Grande, who will act as Mr. Gross' secretary.

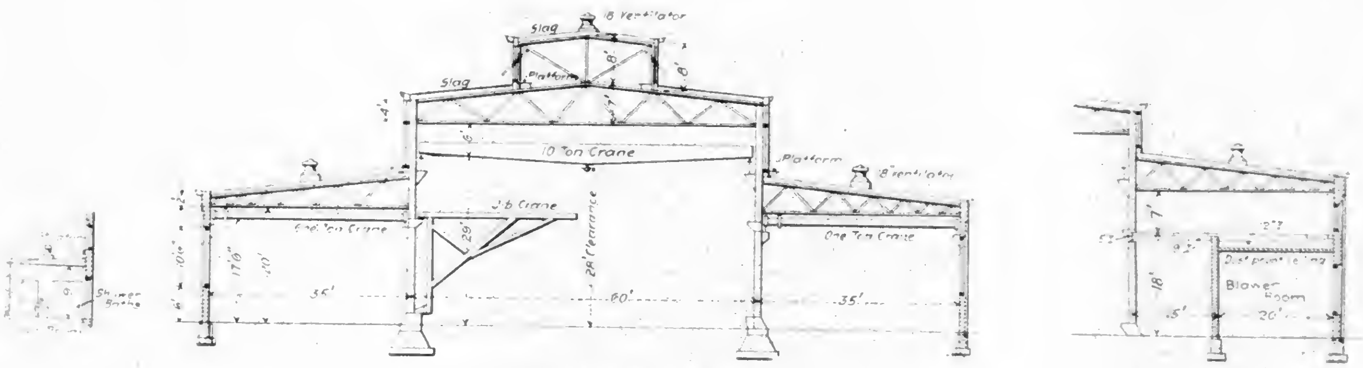
Mr. Max Toltz has resigned as mechanical engineer of the Great Northern Railway. He is engaged in superintending the application of his system of acetylene car lighting to a large number of cars on the Canadian Pacific, and has been retained by that road in a consulting engineering capacity in connection with the new shops at Montreal.



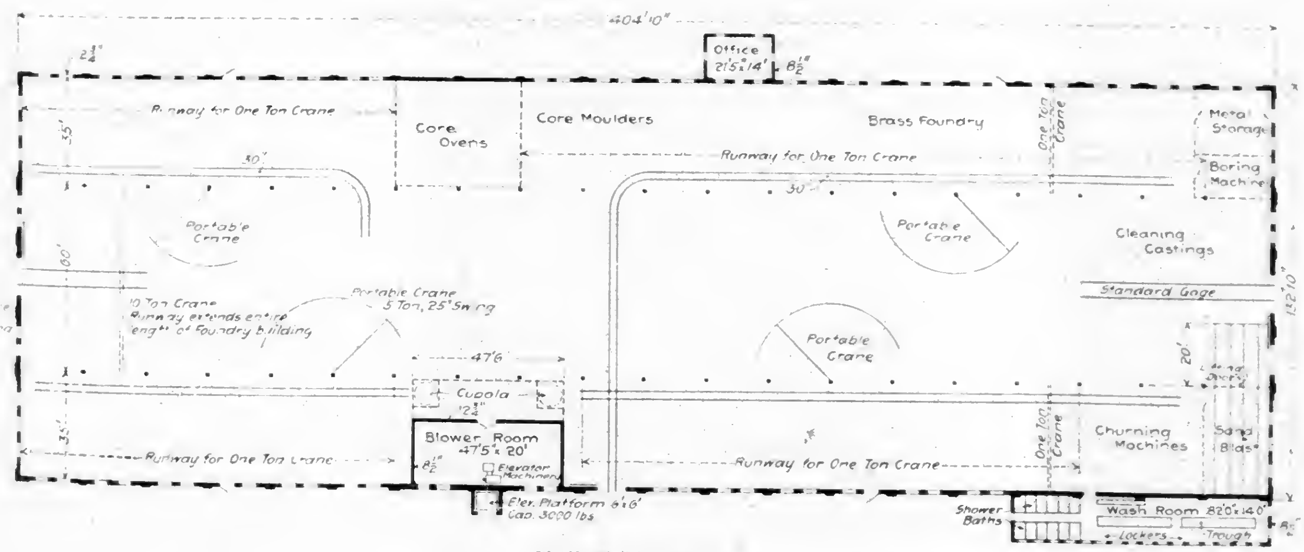
PARTIAL SIDE ELEVATION, END ELEVATION AND SECTION OF BOILER SHOP.



PLAN OF BOILER SHOP.

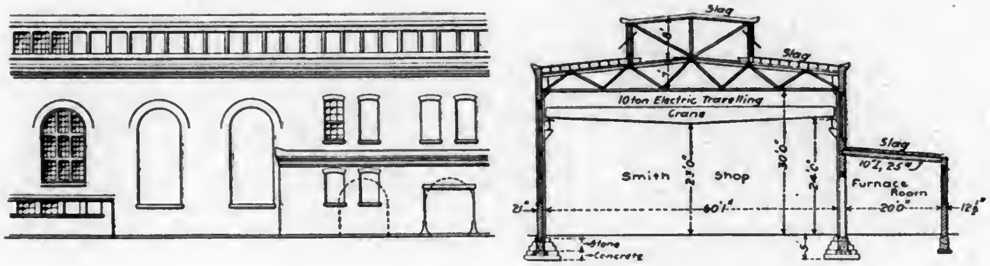


CROSS SECTION OF FOUNDRY.

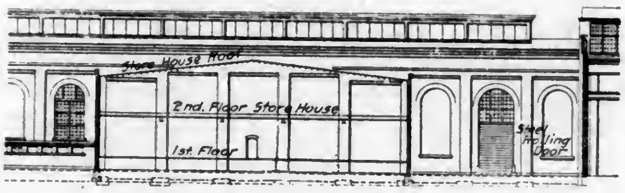


PLAN OF FOUNDRY.

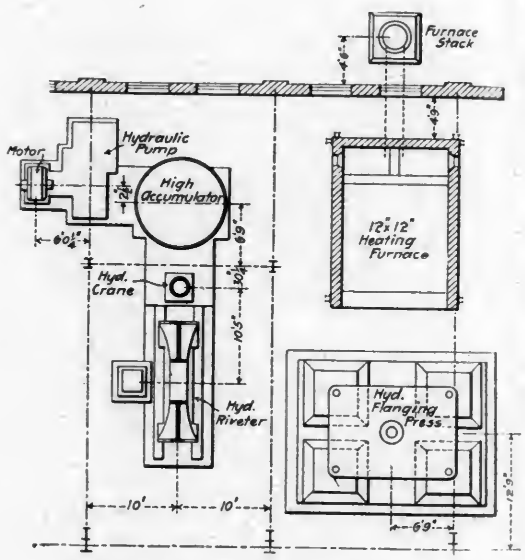
NEW LOCOMOTIVE SHOPS, READING, PA.—PHILADELPHIA & READING RAILWAY.



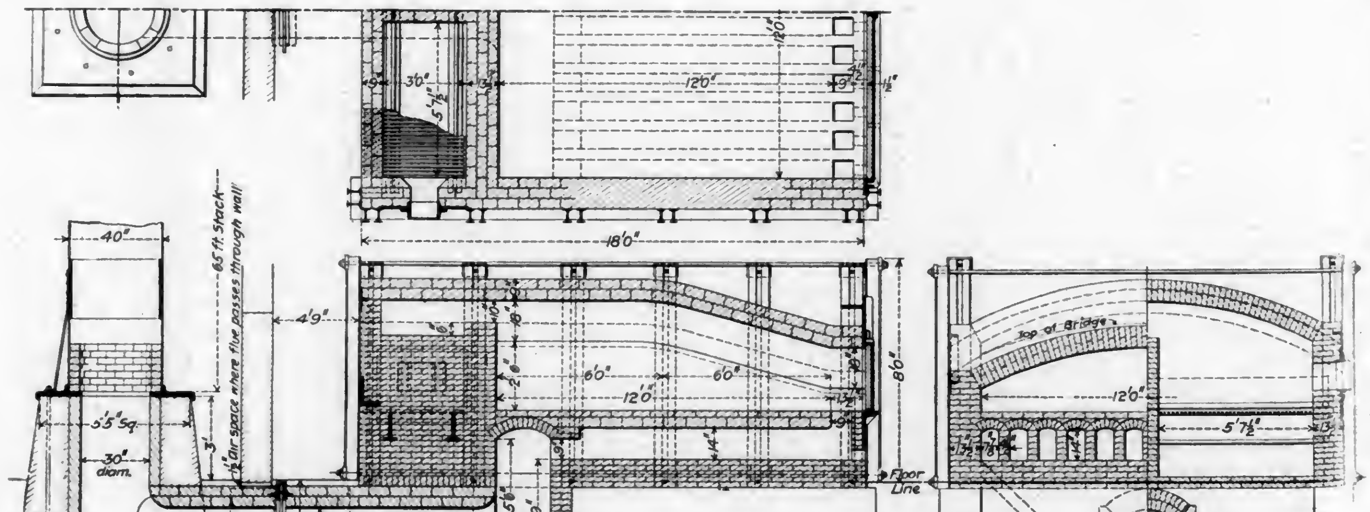
PARTIAL SIDE ELEVATION AND SECTION OF SMITH SHOP.



SECTION THROUGH STOREHOUSE, SHOWING SIDE ELEVATION OF BOILER SHOP.

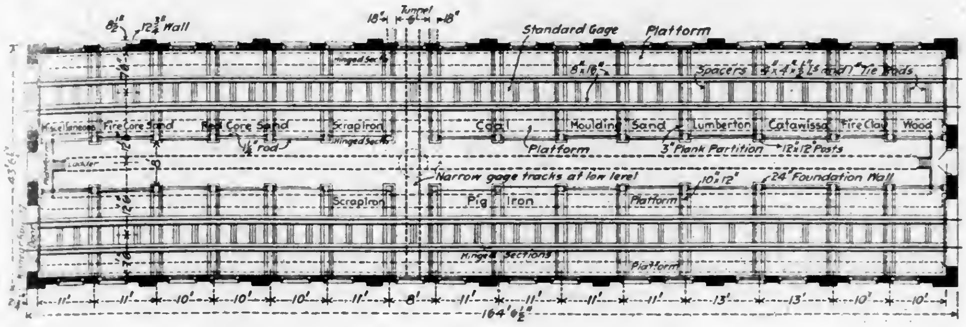


PLAN OF FLOOR UNDER RIVETING TOWER.

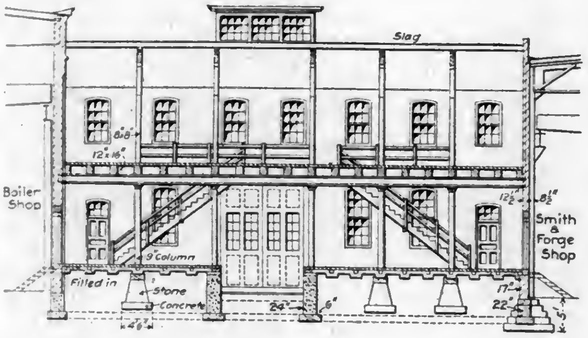


FLANGING FURNACE IN BOILER SHOP.

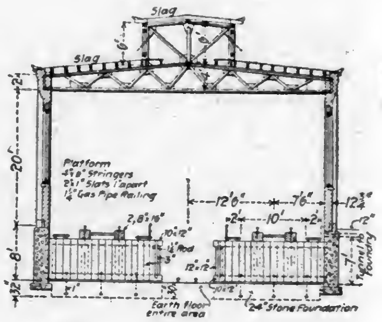
NEW LOCOMOTIVE SHOPS, READING, PA.—PHILADELPHIA & READING RAILWAY.



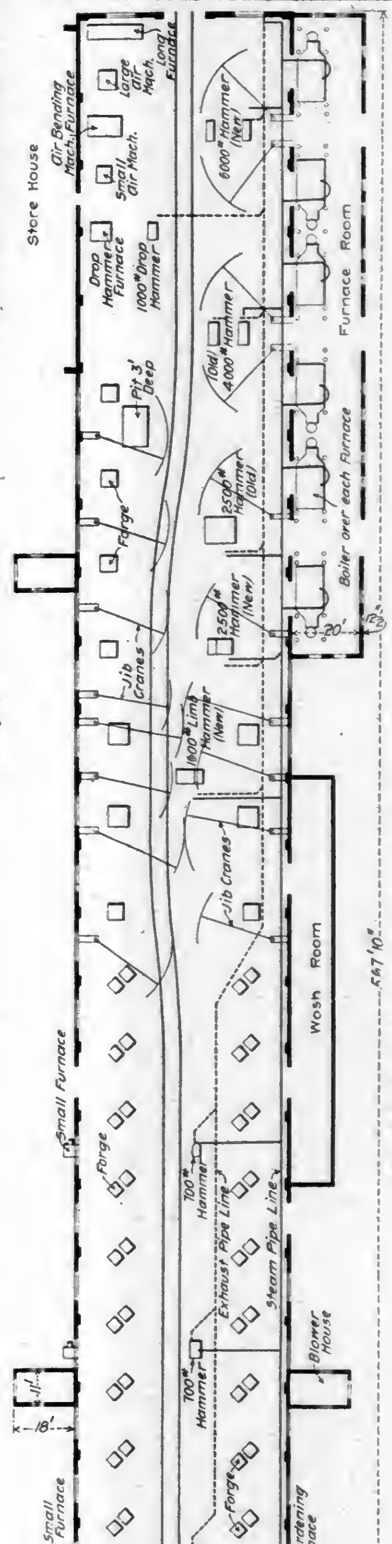
FLOOR PLAN OF FOUNDRY STOCK HOUSE.



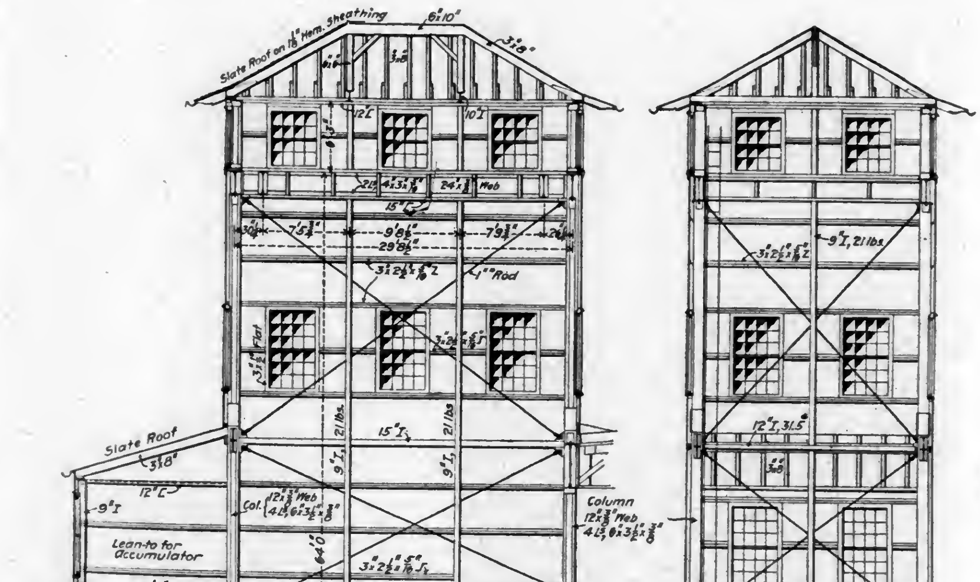
SECTION THROUGH STOREHOUSE.



SECTION THROUGH STOCK HOUSE.



FLOOR PLAN OF SMITH AND FORGE SHOPS.



FRAMING OF RIVETING TOWER.

NEW LOCOMOTIVE SHOPS, READING, PA.—PHILADELPHIA & READING RAILWAY.

NEW LOCOMOTIVE SHOPS.

PHILADELPHIA & READING RAILWAY.

III.

(*For previous article see page* 53.)

In the February number the locomotive erecting and machine shop was described in detail. The other buildings are of similar character but of lighter construction, to adapt them to their special purposes.

BOILER SHOP.

This building has a main bay and a 50-ft. lean-to. The main bay provides for boiler and tank work and is served by a 35-ton crane on runways extending over the dwarf wall into the erecting shop. One track extends through this bay and four other tracks 180 ft. long provide for the tank work. In the lean-to is a space of 400 x 50 ft. for machinery and the riveting and flanging equipment. A monitor extends almost the entire length of the main bay and five ventilators each having 16 sash are provided for in the roof of the lean-to. The arrangement of the glass in the roof is shown in the photograph of this building on page 12 of the January number. This building has a slag roof over hemlock roof boards. The floor of the erecting flue and flange departments is of earth and that of the rest of the building of wood. From the north end of the building to the riveting tower the lean-to is served by a 5-ton electric crane, controlled from the floor of the shop. This covers all of the space over which boiler plates are handled.

The riveting and flanging outfits are placed under a riveting tower located over the roof of the lean-to and about 150 ft. from the north end of the shop. In the tower is a crane to serve the riveter and a small lean-to, on the roof of the shop lean-to and built from the tower, provides for the accumulator for the riveter, flanging press and hydraulic punch. The hydraulic machinery warrants a separate description. The installation of a flanging press in a railroad repair shop is somewhat unusual. In the small plan of the space under the riveting tower the location of the flange furnace is shown and its construction is illustrated by sectional views. The smoke flue passes under the wall of the shop connecting to the stack which is seen in the photograph on page 12.

SMITH AND FORGE SHOP.

This building is 568 x 60 ft. The north half is the forge shop and the south half the smith shop. A lean-to 180 x 20 ft. provides a furnace room outside of the main wall of the forge shop. The roof has a slag covering and the floor is of earth throughout. A 10-ton electric traveling crane serves the entire shop and the forge shop has 17 jib cranes for the hammers and fires. The furnaces are fired with coal. Over each of the six furnaces a horizontal tubular boiler is placed to utilize the waste heat. These furnish steam for the hammers and the exhaust is piped to the general heating system and to the atmosphere through a pressure retaining valve. Smaller furnaces are located in the shop, as shown in the plan, which shows the location of the bending machinery and forges.

THE FOUNDRY AND STOCK HOUSE.

This building is 400 x 130 ft. It has a center and two side bays. A 10-ton crane covers the whole of the center bay and each lean-to has a 1-ton crane operated by compressed air and having shorter runways because of the core ovens and cupolas. In the main bay there are also 4 portable electric cranes. The glazing in this building is shown in the photograph on page 13. In the plan the arrangement of the floor space is indicated.

Special attention was given to the stock house for the foundry. It is seen in the third photograph on page 13. This building is 161 x 40 ft. and has two standard gauge tracks, one on each side, extending into the building at the yard level. Under these tracks are bins for the storage of foundry material. On a level with the floor of this building and the floors of the bins is a push car track with a turn-table at the center of the building. From the transverse track the loaded cars are pushed into the foundry through a tunnel to the foundry elevators to the cupolas or to the foundry floor, as required. Kinnear rolling shutters are fitted to the track doors.

CARPENTER AND PATTERN SHOP.

In this building, 200 x 60 ft., with three and one-half stories, all of the woodwork of the plant is concentrated. The main floor provides for dry lumber storage at the south end, next to this is the paint shop for cabs and special work, while the north end contains the electrician's store-room and repair shop and the scale department. The second floor is used for a general woodworking shop, including the pattern shop. The third and fourth floors are used for pattern storage. This building is well lighted and convenient. It has two exterior elevators with 10 x 12 ft. platforms, one on the south end and the other on the west side of the building. This building has an iron fire-escape at the north end.

STORE HOUSE.

As shown in the general ground plan, on page 10, the storehouse is built between and connected to the boiler and smith shops. It is also near the machine and erecting shops. The building is 100 x 70 ft., two stories high and equipped with an elevator with a 6 x 9 ft. platform. The track running through its center extends also through the locomotive machine shop. The storehouse floor is raised to the level of the floor of a freight car. Between this track and the elevator is a platform scale. Light for the lower floor comes through two wells through the second floor, over which are the roof monitors.

OFFICE BUILDING.

This building has three floors, the second being on the level with the street. The lower floor, 12 ft. below the street level, provides for the offices of the general foreman, shop clerical forces and timekeepers. On the second or main floor are the offices of the superintendent of motive power and master car builder, with their clerks. The arrangement of the rooms was shown in the large ground plan on page 10. A large room occupies the greater part of the floor with a large vault at the north end and toilet rooms in the corners. Other offices are located on each side of the hall at the south end. The drawing room on the third floor is a fine, large, well lighted room. A cement-floored blue-print room, office for the chief draftsman and electrical engineer and the large drawing room occupy the whole floor.

In such large shop buildings it was necessary to employ devices whereby the inaccessible windows in the monitors may be quickly closed in case of sudden storms. In the locomotive shop the sashes are operated in lengths of about 100 ft. by shafts of 1¼-in. pipe. These are rotated by means of air cylinders 6 x 10 ins. in size, which are controlled from a central point at the foot of one of the roof columns. The other buildings have the Evans window-controlling devices supplied by the Quaker City Machine Company, of Richmond, Ind. These are operated by hand.

The power house and machinery equipment of the plant will be the subjects of separate articles.

The Great Western Railway, of England, has ordered a Du Bousquet four-cylinder compound locomotive in order to make a close study of the French locomotives with respect to English conditions. In this case not only the locomotive but the runner, the fireman, and also, perhaps, the fuel, are to be imported for the purpose of testing the merits of the French practice under the best conditions obtainable.

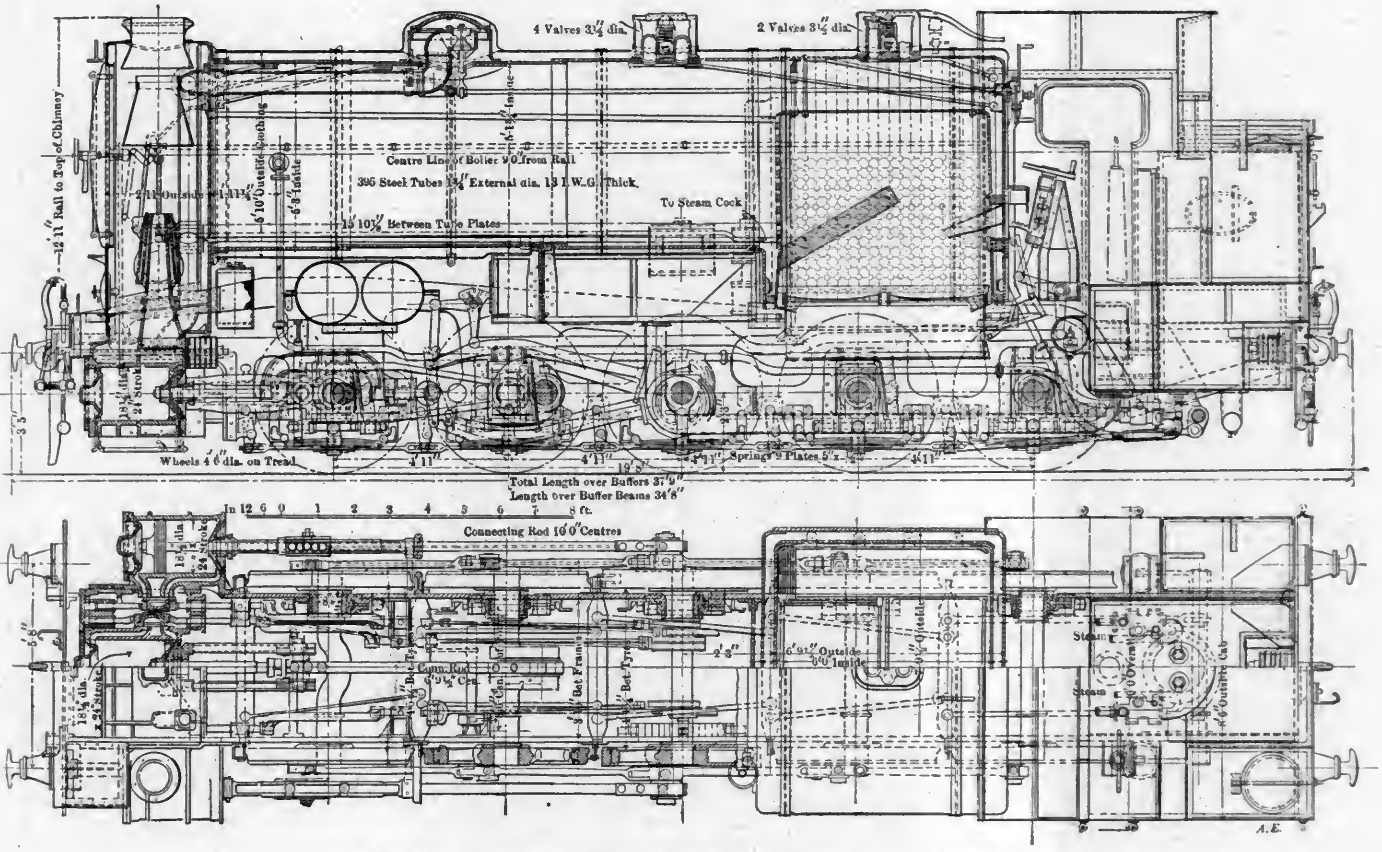
POWERFUL ENGLISH SUBURBAN LOCOMOTIVE.

GREAT EASTERN RAILWAY.

This road has a very important suburban service, which is constantly increasing, and in order to handle it punctually with its existing schedules this interesting locomotive was designed by Mr. James Holden, locomotive superintendent of the road, and one has been built at the Stratford shops.

It has ten 54-in. driving wheels and a wheel base of 19 ft. 8 ins., the central pair being flangeless. It is a simple engine, with three 18½ by 24-in. cylinders, two of which are outside and the other inside the frames. The inside cylinder connects to a central crank on the second axle, and, to provide clearance for the crosshead, the leading driving axle is cranked. The connecting rod is 6 ft. 9½ ins. long between centers, and is made in the form of a triangular frame, one leg of which passes above and the other below the leading axle. The cranks are set at angles of 120 deg. to each other. The boiler is large, and appears to be up to the limit of size for this road. It provides 3,010 sq. ft. of heating surface and 42 sq. ft. of grate area, these figures being the largest ever employed in English locomotive practice. This boiler has six 3½-in. safety valves. The boiler pressure is 200 lbs.

This is a remarkable locomotive, and it gives an impression of the difficulties presented by suburban service of the present time. That the most powerful locomotive in England is designed specially for suburban service indicates the severity of the conditions. We are indebted to *Engineering* for these engravings.



POWERFUL SUBURBAN LOCOMOTIVE, WITH THREE CYLINDERS.

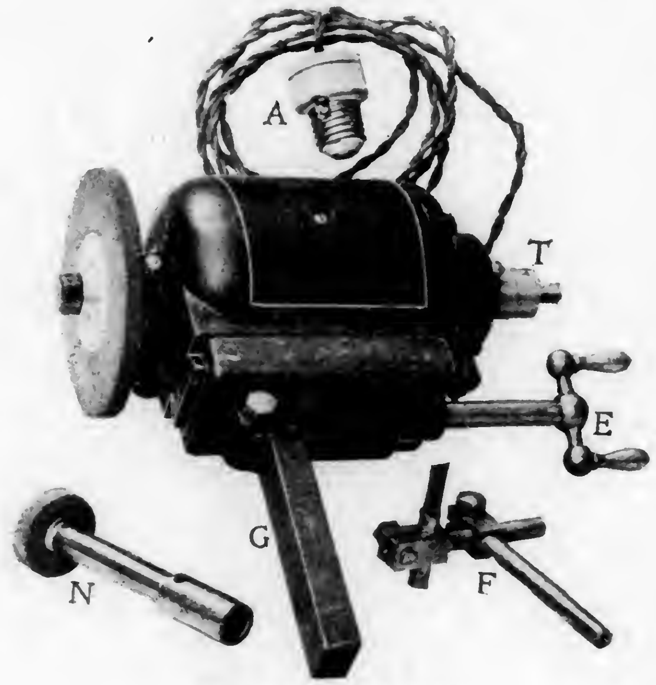
GREAT EASTERN RAILWAY.

ATOMIZERS FOR LIQUID FUEL.

In using oil fuel in marine service the use of steam for atomizing is important, and this was the subject of careful attention by the "Liquid Fuel Board" of the navy department. It was found that with steam atomizing burners the average percentage of steam required for the burners was about 4½ per cent. of the entire evaporation of the boilers. Such a consumption of water that must be made up by evaporators on shipboard leads to the use of air as an atomizing agent. Concerning the matter of steam in the flame, the recent report of Rear Admiral Melville states that there is quite a widespread misconception regarding the part that the steam which is used for atomizing purposes plays in effecting combustion. It is supposed by many that after atomizing the oil the steam is decomposed and that the hydrogen and carbon are again united, thus producing heat and adding to the heat value of the fuel. While it may be true that the presence of steam may change the character and sequence of the chemical reaction, and result in the production of a higher temperature at some part of the flame, such an advantage will be offset by lower temperatures elsewhere between the grate and the base of the stack. All steam that enters the furnace will, if combustion is complete, pass up the stack as steam, also carrying with it a certain quantity of waste heat. The amount of this waste heat will depend upon the amount of steam and its temperature at entrance of the furnace. The quantity of available heat, measured in thermal units, is undoubtedly diminished by the introduction of steam. In an efficient boiler it is quantity of heat rather than intensity that is wanted. For many manufacturing purposes intensity of heat may be of primary importance, but in a marine steam generator a local intense heat is objectionable on other grounds than those of economy, viz.: its liability to cause leaky tubes and seams from the unequal expansion of heating surfaces.

A PORTABLE ELECTRICALLY DRIVEN GRINDING MACHINE.

A valuable feature of the equipment of the new Collinwood shops of the Lake Shore & Michigan Southern Railway is to be found in the addition of a number of the Hisey portable electrically driven grinders for use as attachments to lathes, planers, milling machines, etc., for various grinding operations. The Hisey motor grinder, which was recently put upon



THE HISEY PORTABLE GRINDER.

the market in an improved form by the Hisey-Wolf Machine Company, Cincinnati, Ohio, involves in its construction some valuable features. It is a tool of unusual value on account of its ready and easy application to a large number of otherwise difficult operations, and its time-saving qualities, due to simplicity of application and operation.

This device, which is illustrated in the accompanying engraving, consists of an iron-clad bipolar electric motor, with an emery wheel attached directly upon the end of its armature shaft, the whole of which may be mounted in the tool-post of a machine tool. The motor is built in the most substantial manner, according to a design especially calculated for the high speed necessary. The high speed is obtained by a two-pole design of field magnet frame, which provides a closed magnetic circuit and also a perfect mechanical protection for the armature and its commutator.

The motor illustrated in the engraving runs at a speed of 4,500 rev. per min., a special design of toothed armature being used to withstand this speed. The notchings for receiving the wire are very narrow near the periphery, but widen out farther in; this permits a wedge to be driven in after the armature conductors are in place, which retain them with absolute security. The armatures are wound for either 110 or 220 volts, direct current.

An important feature of this machine is the armature bearings. They are cone bearings at both ends, the cones for which have two ground surfaces, one of 3 degs. and the other of 45 degs. inclination. These cones are tightened up to any degree of tightness by the adjusting nut, T, on the shaft at the commutator end. By this means the true rigidness in running and freedom from end play, so necessary for exact grinding, are perfectly secured.

In using, the tool is mounted by the shank in the tool post of the lathe, milling machine or other machine tool, and started by inserting the extension plug, A, in the nearest incandescent lamp socket. The shank, G, is of steel and is fitted to the cap of the V-way. The V-slide permits a cross adjustment of 3 ins., by means of handle E.

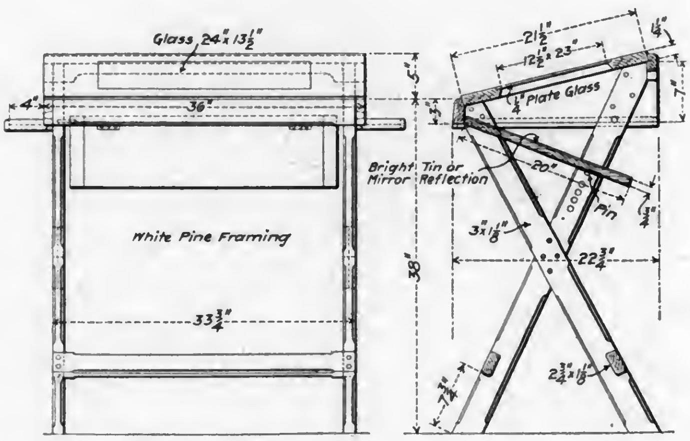
This machine has a wide range of work, such as grinding centers, cutters, reamers, dies, rolls, etc.; also surface, parallel and internal grinding jobs of all kinds. For internal grinding the extension mandrel, N, is used by removing the regular grinding wheel and attaching in its place. This permits grinding in as small a hole as the wheel on the extension mandrel will enter.

The tooth rest, F, is a valuable attachment for the grinder, serving as an index for cutter and reamer grinding, and insuring that each tooth is ground correctly by acting as a stop in rotating the cutter.

For surface grinding the device is very easily attached to the planer or shaper tool post, and used like a cutting tool. One of the best tributes to the general usefulness of this device is the use made of it in the manufacture of its own parts at the Hisey-Wolf shop. A great many of the parts are finished by grinding, but the most difficult of all, the armature core, is ground down not only for smoothness but also the necessary balancing, which is thus secured with perfect ease.

DRAWING TABLE FOR TRACING BLUE PRINTS.

During the early experience of everyone who works in a drawing room difficulties are met in tracing blue prints, especially if the prints are indistinct. Mr. W. R. Maurer, chief draftsman of the motive power department of the Buffalo, Rochester & Pittsburg Railway at Rochester, N. Y., has devised a convenient table for this purpose. The table is of pine, stained, and the complete cost is about $5. The glass is made 1½ ins. smaller than the margin of the standard size sheets



DRAWING TABLE FOR TRACING BLUE PRINTS

used on the road referred to and it is also used conveniently for one-half and one-quarter sheets. A reflector receives light from a window and projects it through the glass under the print. The reflector is hinged. By making the board separate it may be removed from the frame. The under side of the board and the inside of the frame above the reflector are painted white. In using this table it is placed in front of a window and the curtain drawn down so that the strong light comes from below. Mr. Maurer says that with this device it is possible to trace a blue print through a sheet of Whatman's paper.

GRADING OF WASTE.

TESTS DEVELOPING A SYSTEM OF "MERIT MARKING," INDICATING POSSIBILITY OF SPECIFICATIONS FOR COTTON WASTE.

The immense annual consumption of waste by large railroad systems has for a long time rendered apparent the desirability of having a system for definitely grading the various qualities of cotton waste with respect to the results that may be expected. Purchasing from the makers' classifications is indefinite, inasmuch as information is rarely given regarding the relative values of their different classes or brands.

Realizing the importance of this subject and the uncertainty of the properties defining the relative values of waste, the New York Central recently instituted an investigation of various standard commercial brands, with a view of determining data that might eventually lead to the introduction of specifications governing its purchase. The properties which are of the greatest importance in waste, namely, those of absorption, capillarity and expansion resulting from absorption, were determined for several different commercial brands. Nine samples were tested, the analyses of which appear in the accompanying Table No. 1. The absorption and the expansion resulting therefrom are given in per cent. of original volumes, while the capillarity is given both in per cent. of weight and in height, the results obtained appearing in Table No. 2, which exhibits the unexpected variations between standard brands.

An effort was made to compare the effects of the various amounts of foreign matter upon the absorption, expansion and capillarity in height, but the indications were difficult of interpretation. The general indication of this portion of the test points, however, to the fact that the waste is best which has the least foreign matter—that is, the one which is cleanest.

The most important feature of this investigation was the system of "merit marking" developed for summing up the results of the different determinations for facility in comparing total results of each brand. This consists of a numbering or ranking of the various brands tested from 1 up to the total number tested, according to their relative value or merit in each property investigated; that is, the brand having the greatest amount of foreign matter, for instance, is marked 1, the lowest rank; the brand next better is marked 2, and so on. In the same way, the brand giving the greatest absorption is given the highest rank (marked the highest number), and that giving the least is marked 1, the lowest rank. Table No. 3 shows the merit marking for the nine samples tested; brand No. 7 gave the least absorption and was therefore marked 1, while brand No. 2 gave the greatest and was thus marked 9, the highest rank of the nine tested. Where two or more samples gave equally good results in any particular property investigated, they are given the same merit mark or rank down from the highest value. The sum total of the rank numbers received in all the investigations for a sample is used as a basis for comparison of that sample with the others, giving, as it were, the total, or preponderance, of merit of that sample.

It must not be overlooked, however, that this method of comparison may not be strictly exact; this method makes the result of the investigation of each property of equal importance in its effect upon the total, whereas the investigation of one property may be of greater importance than any or all of the others. But no way is apparent for grading the importance of the results of the various properties tested, so it is probable that the method outlined above is approximately correct. It is interesting to note, however, in this connection that in Table 3 the final totals, which establish the actual relative merit of the samples tested, have graded the samples in very nearly the same order as that indicated in the column headed "Total Foreign Matter," thus adding further proof to the statement above to the effect that the less "foreign matter" there is in waste the higher its value.

The information resulting from the tests recorded in Table No. 1 is also important. It shows in one case over 14 per cent. of moisture, oils and fats; in two cases it shows 19 per cent. of dirt and coloring matter, and in another case 31 per cent. of foreign matter. It is of interest also to note that the waste which apparently shows the best in the tests contains the least amount of wool.

Specifications for cotton waste might be drawn up on a basis of the information given in Table No. 1, giving the per cent. of moisture, oils and fats allowed, the per cent. of dirt and coloring matter allowed, and the total per cent. of both, and also the per cent. of wool. The per cent. of coloring matter and dirt and of wool should be less for white waste than for colored waste.

TABLE NO. 1.

Results of Chemical Analyses of Samples of Waste.

No. of Sample.	Moisture Oils and Fats.	Dirt and Coloring Matter.	Total Foreign Matter.	Cotton.	Wool.
1	7.20%	4.30%	11.50%	66.10%	22.40%
2	3.40%	4.60%	8.00%	80.57%	11.43%
3	6.10%	19.00%	25.10%	51.83%	23.07%
4	5.10%	12.70%	17.80%	65.36%	16.84%
5	11.50%	19.50%	31.00%	52.00%	17.00%
6	14.60%	7.10%	21.70%	54.05%	24.25%
7	......	......	......	......	......
8	10.20%	14.30%	24.50%	57.27%	18.23%
9	12.80%	9.30%	22.10%	59.62%	18.82%

TABLE NO. 2.

Tests of Waste for Absorption, Expansion and Capillarity.

No. of Sample.	Absorption, Per Cent. of Volume.	Expansion, Per Cent. of Volume.	Capillarity. Per Cent. by Weight.	Capillarity, by Height — Increase in Inches.
1	424.%	7.80%	215.%	⅜" to 2"
2	489.%	9.17%	270.%	⅜" to 2"
3	352.%	7.80%	165.%	¾" to 1½"
4	441.%	9.17%	170.%	⅝" to 1⅞"
5	434.%	6.25%	110.%	½" to 1"
6	409.%	9.17%	155.%	½" to 2¼"
7	350.%	6.25%	220.%	5-16" to 1¾"
8	470.%	7.80%	125.%	½" to 1½"
9	402.%	7.80%	160.%	½" to 1¾"

TABLE NO. 3.

System of "Merit Marking" for Grading Waste.

No. of Sample.	Total Foreign Matter.	Absorption.	Expansion.	Capillarity. By Weight.	Capillarity. By Height. Solid.	Capillarity. By Height. In Strands.	Totals, giving Preponderance of Merit.
	Relative Values.						
1	8	5	3	7	7	9	44
2	9	9	9	9	7	9	52
3	3	2	8	5	7	6	31
4	7	7	9	6	9	8	46
5	2	6	7	1	8	5	29
6	6	4	9	3	8	9	39
7	..	1	7	8	6	7	..
8	4	8	8	2	8	6	36
9	5	3	8	4	8	7	35

The University of Michigan has under construction at present a much needed new building for its engineering departments. It will be very complete in its appointments, costing about $140,000, and will have a naval testing tank, a compressed-air laboratory, a hydraulic laboratory, refrigerating and cold storage apparatus and other valuable equipment.

A Lighthouse in a Desert.—There is at least one lighthouse in the world that is not recorded on any mariner's chart. It is away out on the Arizona desert, and marks the spot where a well supplies pure, fresh water to travelers. It is the only place where water may be had for forty-five miles to the eastward and for at least thirty miles in any other direction. The "house" consists of a tall cottonwood pole, to the top of which a lantern is hoisted every night. The light can be seen for miles across the plain in every direction.

DEVICE FOR SPACING DUNBAR PACKING RINGS.

The accompanying drawing represents an improved device for spacing Dunbar or similar packing rings. This device is not essentially different from the one devised by Mr. George Wales, of the West Burlington shops of the Chicago, Burlington & Quincy Railway, which was described on page 89 of our March, 1902, issue. It consists of a circular cast-iron plate, 22 ins. in diameter, with circles scribed upon its face to correspond with various sizes of pistons, the range being from 12 to 22 ins. in diameter. At the center of the plate is pivoted a forked bearing, which supports a rod extending to the edge of the plate; thus the rod may be raised and swung around

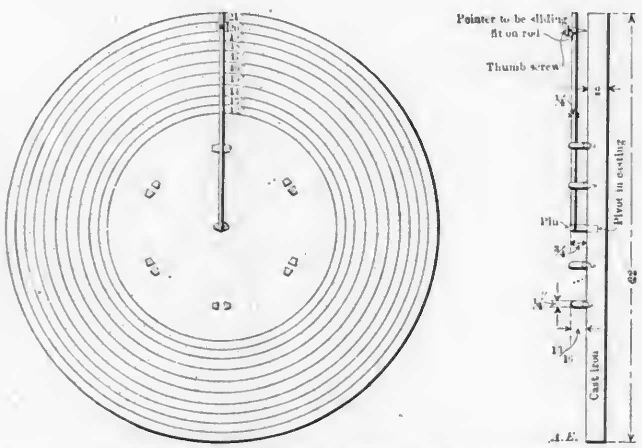


PLATE FOR LAYING OUT DUNBAR PACKING RINGS.

to any position, clips being arranged to firmly hold it at 60-degree points around the circle. An adjustable sliding pointer is arranged on the rod so that it may be clamped in any position thereupon. When the bar is dropped into one of the clips it is in position for making one of the marks on the ring to be cut; then by dropping it into all the rest of the slots and making marks by the sliding pointer, the six equidistant marks necessary for this kind of packing may be made. This has proved a very rapid combination and has many advantages for quick work. We are indebted to Mr. H. F. Killeen, of Davenport, Iowa, for this information.

The vessels which have at present the record for the most economical machinery are the steamers *Inchdune* and *Inchmarlo*, whose machinery, like that of the *Iona*, was built by the Central Marine Engine Company, of West Hartlepool. The engines are not of great size, the aggregate indicated horse-power being only 1,600. The steam pressure carried is 267 lbs. There are five cylinders, two being low pressure, but the expansion is in four stages. The cylinder diameters are 17, 24, 34 and 42 ins., the stroke of all pistons being 42 ins. The coal per horse-power on the trial trip from Hartlepool to Dover was the unprecedentedly small amount of 0.97 lb. In this machinery everything which would contribute to economy has been adopted. The steam is superheated to a temperature of about 500 deg. F., and all the cylinders, except the high pressure, are jacketed, both on the barrel and on the ends. The feed water is heated to a temperature of about 370 deg., and a light artificial draft of the induced type is used, while the boilers are fitted with Serve tubes. The economy attained in this machinery of getting a horse-power for about one pound of coal is certainly remarkable, and it makes a record which it will be difficult for other designers to excel, if, indeed, in vessels of large power, it can be reached.—W. M. McFarland, in *Engineering Magazine.*

PLANER AND MATCHER FOR THICK STOCK.

S. A. Woods Machine Company.

A special demand has developed for a heavy planer and matcher to fill the gap between the ordinary fast feed matcher and a large timber sizer. Such a machine of modern construction has been needed to perfectly dress and match thick flooring timbers, boards and other material used in car building. The S. A. Woods Machine Company of South Boston, Mass., have applied their long experience and knowledge of the requirements of car builders to the problem and have produced what is known as the "Woods No. 10, Extra Heavy Planer and Matcher" as their latest attainment.

The last few years have brought many changes in the construction of planing machines, which have helped to greatly increase the capacity and quality of the work. The principle, however, is not changed and remains the same as it has been since the introduction of the cutter-head, but the operation of the machines has been improved as stated. One of the greatest improvements is the application of the wedge platen used in this machine, as described below. This is a feature patented and controlled by these builders and is deserving of wide attention.

The adjustable wedge platen permits of changing the cut or distributing it between the top and bottom cutter-heads without either disturbing the top rolls or altering the finished thickness of the lumber. This feature also allows of instantly adjusting the machine for surfacing on one side only and with it scant sawed lumber may be made full dressed thickness. The adjustment is made from the feeding in end, from which point the moveable parts may be instantly locked in place after they are adjusted. The device resembles the table of a buzz planer, adjustable on inclines. The platen plate under the top cutter-head rests on an inclined bed which may be raised or lowered simultaneously with the lower feeding in rolls, thus increasing or diminishing the cut of either head, as desired.

Knife setting gauges which are adjustable to give the desired projection of the knife over the lip of the cutter head, permit the accurate setting of knives without measurements or the use of other instruments. Binding levers take the place of wrenches for locking the adjustable parts of the machine. The feed is arranged so that it may be operated from either end of the machine. Three distinct styles of feed can be furnished with this machine as preferred: That shown in the engraving on page 119, a friction cone feed, or a tight and loose pulley feed. The power hoist facilitates the adjustment of the top rolls and cutter-head simultaneously, or the feeding-in rolls independently. The top cutter-head may be disconnected from the regular hoisting mechanism and the rolls adjusted independently.

The bottom cutter head and its yoke are arranged to draw out by a screw, facilitating access to the knives. The system of applying pressure to the top feed rolls from below obviates overhead weights. The pressure bar or platen over the bottom cutter head acts as a gauge for thickness of the finished stock and may be adjusted in a parallel plane, or either end may be disconnected from the hoisting mechanism and raised or lowered independently, all from the operating side.

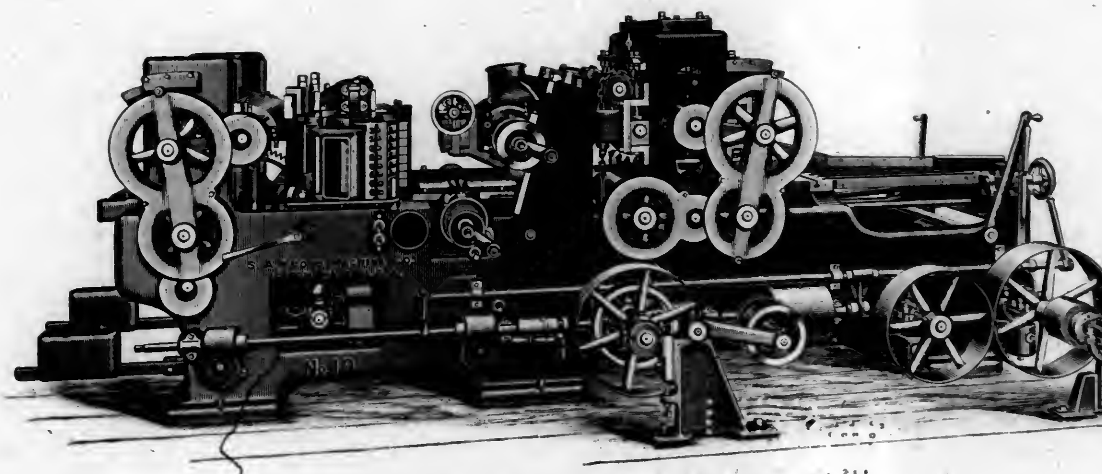
Both the top and bottom cutter heads are double belted, the upper feeding in rolls are solid, although sectional rolls and expansion center guides may be applied if desired. There are six feed rolls, 9½ ins. in diameter. The side chip breakers are sectional with shoes independently adjustable. The expansion gearing is properly covered and ample provision is made for taking away all shavings, etc.

The machine is built to work 18 to 30 ins. wide up to 12 ins. thick. Its special features are covered by patents.

BOOKS AND PAMPHLETS.

Ancient and Modern Engineering and the Isthmian Canal. By Wm. H. Burr, Professor of Civil Engineering, Columbia University. 8vo, 473 pages; profusely illustrated. 1902: John Wiley & Sons, 43 East Nineteenth street, New York. Price, $3.50; postage, 27 cents additional.

The basis of this book is a series of six lectures delivered by Professor Burr in 1902 under the auspices of Columbia University. The lectures have been somewhat elaborated for this publication. The first part, on ancient civil engineering works, contains much of interest and covering considerable range, most of it not readily available in engineering literature. The second part, on bridges, touches the subject somewhat technically as well as historically and is well up to date in methods of treatment and in the features covered. The same is true of part three, on waterworks, which is treated from many standpoints, some of which are too new to have received complete and up-to-date attention in most text-books. Filtration, in particular, and also purification, waste and storage, receive intelligent attention. The railroad part, after touching upon the general subject interestingly, looks more particularly into signalling and the development of the locomotive. Parts five and six have to do with the Nicaragua and the Panama routes for a ship canal, which Professor Burr can treat somewhat authoritatively, being a member of the canal commission. Of course, this matter is both new and interesting. It is not altogether usual to find so much of solid good and so little that fails to prove of value, especially in a book with such an origin as stated above. The book is finely printed and is full of half-tone and other illustrations. Altogether it is both an attractive and a valuable book for any engineer's library.



PLANER AND MATCHER FOR THICK STOCK,

S. A. WOODS MACHINE COMPANY.

(FOR DESCRIPTION, SEE PAGE 118.)

The Sea Coast. (1) Destruction, (2) Littoral Drift, (3) Protection. By W. H. Wheeler, M. Inst. C. E. Illustrated. Longmans, Green & Co., 91 Fifth Avenue, New York. 1902. Price $4.50.

The purpose of the writer of this book is to present clearly the conditions of the sea coast which arise from the varying agencies of change and degrees of exposure. After a brief general consideration of the sea coast and of the destructive action of shore waves, the author gives a more extended treatment of the littoral drift. In portraying this important part of the action of the sea the author describes notable examples which represent the diverse effects in various countries. One chapter is devoted to a general description of sea walls. In another chapter examples of sea walls are described and their construction illustrated. Another chapter treats upon groynes, their construction, use and advantages. The coast of England has an important history and is an interesting study which merits the descriptions which Mr. Wheeler gives of it at various points. His final chapter is upon the coasts of the north of France, of Belgium and of Holland. The author clearly describes the conditions of the coasts, and his conscientious care and accuracy enhance the value of the volume. He appreciates the importance of a knowledge of the physical conditions to the engineer who seeks either to evade or to resist the destructive power of the sea by the structures which he designs.

The Steam Turbine. By E. H. Sniffin. The paper upon this subject by this author, read before the American Street Railway Association at the recent Detroit meeting, has been reprinted in pamphlet form by Westinghouse, Church, Kerr & Co., and copies may be obtained from any office of that company.

"Leading Newspapers" is the title of a convenient little book of 200 pages published by Geo. P. Rowell & Co., 10 Spruce street, New York, in which the leading papers are discussed from the standpoint of the advertiser. The bulk of the space is occupied by a list of leading papers, including newspapers and journals devoted to special classes of readers. The list states the circulation of each in case the publishers are willing to disclose the figures for the purpose. It is a valuable little book which will be very convenient for reference by the advertiser. Its price is $1.

The Joseph Dixon Crucible Company have distributed a souvenir pamphlet of the inspection trip of the American Society of Civil Engineers to the new terminal of the North German Lloyd Steamship Company at Hoboken on the occasion of the fiftieth annual meeting of that society, held in New York in January. The pamphlet presents construction views of this fireproof terminal, and notes the fact that the entire structural steelwork of the buildings and piers is protected with Dixon's silicon graphite paint. The pamphlet presents an excellent idea of the construction of this interesting group of structures. It is well worth sending for.

The American Blower Company, Detroit, Mich., have issued two new pamphlets. The first illustrates the application of their heating and ventilating system to a number of large manufacturing plants and railroad shops. The illustrations present typical large plants, and the text gives the reasons for the adaptability of the fan system of heating to them and the reasons why it is the only economical and satisfactory method of heating large buildings. The pamphlet gives an excellent general idea of the "A. B. C." system. The other pamphlet is devoted to the "A. B. C." moist air dry kiln patented by this company. This little pamphlet is intended to give enough information to lead to requests for the larger catalogue, No. 139, which may be had upon application.

Frogs, switches, switch-stands, rail-braces and similar equipment manufactured by the Weir Frog Company, of Cincinnati, Ohio, are illustrated and described in "Catalogue No. 6," just issued by them. This is a popular and convenient catalogue. Its purpose is to present by numbered engravings the varieties of work this firm is prepared to furnish, and those desiring this material will do well to read the concise statements made in connection with these illustrations, and apply for further information if necessary. The chances are that orders may be based upon the catalogue, so great is the variety of work shown. At the end of the book is a valuable collection of twenty-two tables containing information concerning track and track work. Railroad officers and others who have anything to do with track work should procure a copy of this catalogue.

The Counsellor.—A unique and interesting publication bearing this title has come from the office of Clarence P. Day, 140 Nassau street, New York. It is devoted to the interests of mechanical trade and class advertisers, advertisement writers and publishers. It stands for scientific treatment of the problem of publicity, and its pages are full of suggestions, both in the form of text and illustration. The underlying idea presented is that advertising to be effective must be directed by specialists. Mr. Day is well qualified by ability and experience to advise and conduct active campaigns in this service, and his "advertising shop," from which this interesting publication comes, is evidently well equipped in all particulars for effective work. The Counsellor will appear as a quarterly, and probably later as a monthly, publication. It is a fine piece of printing, the color work on the covers being especially pleasing and effective.

The Jeffrey Manufacturing Company, Columbus, Ohio, have issued a pamphlet describing the Barney brick-conveyor system. In a number of well-selected engravings the application of this simple system of conveyors to the service of brickyards is shown. These conveyors are built for capacities varying from 5,000 to 35,000 bricks per hour, either loaded on cars or piled in storage. Those who have had to do with handling bricks by the hand-labor and wheelbarrow method will at once appreciate the advantage of this system, which not only cheapens the handling but greatly increases storage capacity. The essentials of this system are an endless carrier chain, a series of swinging baskets, and an overhead track or runway. The pamphlet also describes other well-known specialties of this company in conveyors and allied machinery.

INDUSTRIAL NOTES.

The Railway Appliances Company and the Q. and C. Company announce that they have consolidated interests and that the business of both concerns will be continued under the name of the Railway Appliances Company, Old Colony Building, Chicago, with the following officers: Mr. H. K. Gilbert, president; Mr. C. F. Quincy, vice-president; Mr. G. H. Sargent, manager, and Mr. Percival Manchester, secretary.

A large installation of Nernst lamps is to be made in the Farmer's National Bank building in Pittsburg, which is to be the largest business building in that city. The Westinghouse Electric and Manufacturing Company have furnished three 150 kw. and one 75 kw. alternating current generators and the entire building will be lighted with Nernst lamps, as follows: One thousand 55-watt single-glower, 1,250 88-watt single-glower, 20 two-glower and 20 six-glower lamps. This is a high tribute to this lamp.

The Chicago Pneumatic Tool Company has issued through President Duntley a financial statement for the year ending December 31, 1902, showing its financial condition to be very strong and its business to be most satisfactory and gratifying. In order to concentrate manufacture and improve the facilities for meeting the increased demands of purchasers, the Aurora factory is to be consolidated with the Cleveland plant. This will greatly increase the output. In his address to the stockholders President Duntley states that the business for January, 1903, was 50 per cent. greater than that of the same month in 1902.

The O. M. Edwards Company, of Syracuse, N. Y., inform us of a change in their office in Chicago. Mr. B. S. McClellan has been appointed Western manager, to succeed Mr. E. E. Silk, who has resigned. Mr. McClellan has charge of the Western territory and the office in the Fisher building, Chicago.

The Philadelphia Bourse is evidently appreciated as an effective factor in bringing manufacturers of machinery and products before purchasers through the exhibition department. The present year opens with a number of new exhibitors and enlarged spaces have been taken by others who have been using these excellent facilities. Applications should be made to Mr. W. H. Rogers, superintendent The Bourse, Philadelphia, Pa.

The Holland Company, with main offices in the Great Northern Building, Chicago, have opened an office in San Francisco, 508 Market street, with Mr. F. F. Small as Pacific Coast manager. Previous to his connection with the Holland Company Mr. Small was for many years draughtsman of the Southern Pacific Company, and recently engineer of tests on the Mexican Central. The Holland Company, besides handling their own patented specialties, are also Pacific Coast representatives of the H. W. Johns-Manville Company's products; also those of the Dake Engine Company, and sole agents for the Marion Malleable Iron Works on the Pacific Coast.

A prospectus of the Magnolia Metal Company offering $200,000 of 7 per cent. preferred stock has been received. This issue is for the purpose of increasing the working capital and for business extension due to the large expansion of business. In addition to the manufacture of Magnolia Metal and Defender, Mystic and Kosmic this company now produce every grade of babbitt, linotype, stereotype and other similar metals. The steady growth of the business of the company has been noted and the plan of increasing its capital will undoubtedly add an important advantage. Subscriptions may be sent direct to the Magnolia Metal Company, 511 West Thirteenth street, New York City.

The New York Central & Hudson River Railroad has recently placed an order with Westinghouse, Church, Kerr & Co. for four Westinghouse-Corliss engines of the horizontal cross-compound type. These engines will form the main power equipment of a new power station in process of erection on the company's property at Weehawken, N. J., which will supply power to the grain elevators and shops there located. Two of the engines are of 1,200-h.p. normal capacity and the remaining two of 700 h.p., each pair being direct-connected respectively to 750 and 400-kw. polyphase generators of the revolving field type. They will operate with 140 lbs. of steam superheated to 500 degs. F., and with high vacuum. The equipment also includes a small exciter engine of the Westinghouse vertical compound type.

The steam turbine equipment of the Hartford Electric Light Company, Hartford, Conn., is to be duplicated in the near future by machines manufactured by the builders of the original installation, the Westinghouse Machine Company, Pittsburg, Pa. The present Corliss engine equipment will be replaced by two 1,000-h.p. turbines, direct-connected to revolving field polyphase generators. These units will operate in parallel with the 1,300-kw. unit installed one year ago and were chosen for the purpose of securing the utmost flexibility and economy in the operation of the plant. The turbine plant will operate with superheated steam, with 150 lbs. pressure and a high vacuum. The original installation created much interest among engineers and power users, and it is a gratifying reflection that the first American steam turbine of large size has given such immediate satisfaction as to warrant an extension of the turbine equipment and the relegation of the steam engine, after one year's operation. Although the Westinghouse-Parsons steam turbine has been on the market less than four years, 4,000 kw. of turbine machinery have been put into service and 75,000 kw. have been contracted for. The Westinghouse Machine Company find it necessary to build a new turbine shop to meet increasing demands. This turbine is controlled by Westinghouse, Church, Kerr & Co., New York.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL.

RAILWAY SHOPS.

BY R. H. SOULE.

III.

THE ERECTING SHOP.

Erecting shops may be broadly grouped as either longitudinal or transverse; longitudinal when the stall tracks run lengthwise of the shop, transverse when they run crosswise. In the longitudinal shop three tracks run through the shop; in the transverse shop any number of tracks (according to the length of the building) run across the shop. In the longitudinal shop the overhead traveling cranes for lifting engines must be two in number; in the transverse shop but one such crane is required, although a second and lighter crane on a lower level is often provided. In the longitudinal shop engines are brought in on the middle track, are generally stripped and unwheeled on that track, and are then placed on one of the side tracks for repairs. In a transverse shop which is provided with an adjacent transfer table, engines may be run in on any track. If there is no transfer table, engines are brought in on some one designated track, and lifted (over intermediate engines, if necessary) to some other track: they may be stripped and unwheeled either on the track on which they are brought in, or on the track on which they are subsequently placed; practice varies in this respect. Fig. 1 is a typical cross-section of a longitudinal shop; Fig. 2 of a transverse shop, with crane equipment on one level; Fig. 3 of a transverse shop with crane equipment on two levels; Fig. 4 is that particular modification of the Fig. 2 type which is found in the case of the Baldwin Locomotive Works at Philadelphia. Tables 1, 2 and 3 give the essential dimensions and data for several shops of each type.

First considering longitudinal shops in connection with Fig. 1 and Table 1, an examination of column B discloses a marked tendency to increase the spread of the tracks. In the early shops this spread was 18 ft.; in 1902 a spread of 22 ft. was common practice, and in 1903 a spread of 24 ft. 9 in. appears (in the case of the new Canadian Pacific shop at Montreal), while it is also known that another road intends to make the

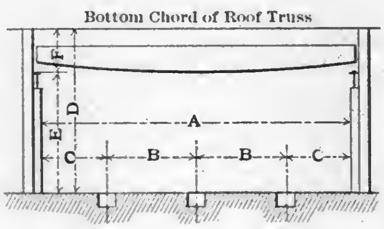


FIG. 1.—CROSS-SECTION OF LONGITUDINAL ERECTING SHOP.

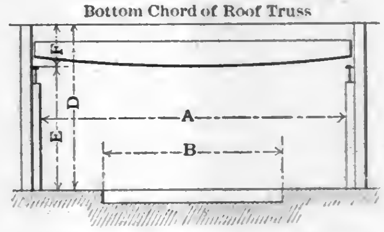


FIG. 2.—CROSS SECTION OF TRANSVERSE ERECTING SHOP. CRANES ON ONE LEVEL. WITH OR WITHOUT TRANSFER TABLES AS NOTED IN TABLE 2.

TABLE 1.—DATA FOR LONGITUDINAL ERECTING SHOPS. (See Fig. 1.)

Place.	R. R.	Year built.	Approx. Cross Section Dimensions. Horizontal. A	B	C	D	Vertical. E	F	Approx. Length of Shop.	Loco. Standing Cap'y Side-tracks only. No.	Ft. per engine.	Cranes. s. t. = sing. trolley.	Machine Shop Location.
			ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft.		ft.	s. t.	
Altoona, Pa., No. 1	Penna.	1875	57—0	18—0	10—6	29—8	21—11	7—9	350	18	39	2, 65-ton	One side, sep. bldg.
Altoona, Pa., No. 2	Penna.	1883	57—0	18—0	10—6	29—8	21—11	7—9	350	18	39	2, 65-ton	One side, sep. bldg.
Roanoke, Va.	N. & W.	1883	55—10	18—0	9—11	28—4	21—6	6—10	245	10	49	2, 40-ton	One side, sep. bldg.
Burlington, Iowa ..	C., B. & Q.	1883	56—6	20—4	7—11	31—6	23—2	8—4	315	12	52	2, 30-ton	One side, same bldg.
Alt'na, Pa. (Juniata).	Penna.	1891	60—6	19—6	10—9	32—0	24—1	7—11	100	6	50	2, 65-ton	One side, sep. bldg.
Baltimore, Md.	B. & O.	1896	67—8	19—0	14—10	28—4	20—4	8—0	624	30	41	2, 50-ton	One side, same bldg.
Concord, N. H.....	B. & M.	1897	65—4	20—0	12—8	32—0	24—0	8—0	305	14	44	2, 30-ton	Both sides, same bldg.
Dubois, Pa.	B., R. & P.	1901	67—4	22—0	11—8	38—0	27—0	11—0	340	12	57	2, 50-ton	Both sides, same bldg.
Elizabethport, N. J.	C. R. R. of N. J.	1902	79—4	22—0	17—8	40—0	30—0	10—0	450	18	56	2, 50-ton	One side, same bldg.
Omaha, Neb.	U. P.	1902	68—8	23—0	11—4	40—0	30—1	9—11	400	18	44	2, 50-ton	One side, same bldg.
Topeka, Kan.	A., T. & S. F.	1903	69—0	23—0	11—6	41—8	25—0	16—8	500	22	45	2, 60-ton	Both sides, same bldg.
Montreal, Can.	C. P.	1903	75—0	24—9	12—9	36—6	27—0	9—6	900	40	45	2, 60-ton	One side, same bldg.
Jackson, Mich.	M. C.	1903	70—4	22—0	13—2	40—1	27—6	12—7	350	14	50	2, 60-ton	Both sides, same bldg.
Portsmouth, Ohio ..	N. & W.	1903	68—2	22—6	11—7	35—0	28—0	7—0	150	6	50	2, 60-ton	One side, sep. bldg.

TABLE 2.—DATA FOR TRANSVERSE ERECTING SHOPS WITH CRANES ON ONE LEVEL. (See Fig. 2.)

Place.	R. R. or Loco. Co.	Year built.	Approx. Cross Section Dimensions. Horizontal. A	B	D	Vertical. E	F	Approx. Length of Shop.	Available Stall Tracks. No.	Spread C to C.	Cranes, s. t. = sing. trolley. d. t. = d'ble trolley.	Machine Shop Location.
			With Transfer Table.									
			Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft.		Ft. Ins.		
Bloomington, Ill.	C. & A.	1883	58—8	34—0	26—3	21—6	4—9	404	16	22—0	2 d. t., 50-ton	One side, same bldg.
Schenectady, N. Y.....	Am. Loco. Co.	1892	61—0	34—0	34—0	27—6	6—6	317	17	17—0	2 d.t., 40-ton	One side, sep. bldg.
Burnside, Ill.	I. C.	1892	74—6	67—6	31—6	21—0	10—6	550	24	22—0	1 d.t., 100-ton	One side, same bldg.
Depew, N. Y.........	N. Y. C.	1893	65—0	36—0	34—0	22—6	11—6	{500 500}	46	20—0	2 d.t., 60-ton	One end, sep. bldg.
Fond du Lac, Wis.....	W. C.	1900	57—8	32—9	27—2	20—2	7—0	329	15	22—0	2 d.t., 30-ton	One side, same bldg.
Oelwein, Ia.	C. G. W.	1900	57—4	35—0	33—6	26—4	7—2	390	13	25—0	{1 s.t., 15-ton 1 d.t., 65-ton}	One side, same bldg.
Brainerd, Minn.	N. P.	1900	(e. s. & m. s. in three bays 130′ over all)					570	25	22—0	{Crane in middle bay only}	One side, same bldg.
Hannibal, Mo.	H. & St. J.	1901	61—3	45—0	34—0	26—5	7—7	227	10	22—6	{1 s.t., 15-ton 1 d.t., 70-ton}	One side, same bldg.
Baring Cross, Ark.....	M. P.	1902	68—0		35—2	26—3	8—11	330	15	22—0	{1 s.t., 15-ton 1 d.t., 70-ton}	One side, same bldg.
Oak Grove, Pa........	N. Y. C.	1903	68—6	40—0	40—0	28—0	12—0	425	19	22—0	{1 s.t., 30-ton 1 d.t., 75-ton}	One side, same bldg.
			Without Transfer Table.									
Philadelphia, Pa.	B. Loco. Wks.	1891	See Fig. 4. (No. Pits.)					335	19	16—0	2 d.t., 100-ton	One side, sep. bldg.

Note: The heavy cranes at Oelwein, Hannibal, Baring Cross and Oak Grove are "dummies," i. e., can only lift by their own mechanism; the trolleys are moved by hand, and the bridge by the light crane.

spread 25 ft. at proposed new shops. This means that the width of the shop between crane runway posts (dimension A) must be at least 76 ft., and permits the free movement of engines, when hung from the cranes, between other engines standing on the middle and side tracks. Similarly the height of shop from floor to roof truss (dimension D) has increased until 40 ft. appears to be about normal. The average length of track occupied by each engine approximates 45 ft.

Next, considering transverse shops in connection with Figs. 2 and 3 and Tables 2 and 3, it is evident that a width of 65 ft. between crane runway posts (dimension A) is sufficient for slinging and handling engines by the overhead cranes even in those transverse shops which have no transfer table (Fig. 3 and Table 3) and are entirely dependent on overhead cranes. Where this width is made more than 65 ft. it is generally done with the object that the overhead cranes may serve a fringe of heavy tools which are placed along one edge of the erecting shop bay. In the five transverse construction shops the spread of stall tracks ranges from 14 ft. to 17 ft., which makes it hard to justify a spread greater than 20 ft. in the transverse repair shop, especially if strippings are stored elsewhere than between stalls on the floor level. It is evident that the height (dimension D) of a transverse shop equipped with cranes may vary between the extremes of 35 ft. and 50 ft., but if we assume that it is desirable to have at least enough head room to lift a boiler over an engine, 40 ft. becomes the minimum, and three heights may be taken as representative of different combinations, as follows:

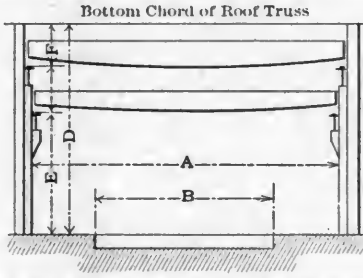


FIG. 3.—CROSS SECTION OF TRANSVERSE ERECTING SHOP. CRANES ON TWO LEVELS. WITHOUT TRANSFER TABLES.

TABLE 3.—DATA FOR TRANSVERSE ERECTING SHOPS WITH CRANES ON TWO LEVELS. (See Fig. 3.)

Place.	R. R. or Loco. Co.	Year built.	A (Horizontal) Ft. Ins.	B (Horizontal) Ft. Ins.	D (Vertical) Ft. Ins.	E (Vertical) Ft. Ins.	F (Vertical) Ft. Ins.	G (Vertical) Ft. Ins.	Approx. Length of Shop. Ft.	Available Stall Tracks. No.	Available Stall Tracks. Spread C to C. Ft. Ins.	Cranes, s. t. = sing. trolley. d. t. = d'ble trolley.	Machine Shop Location.
Without Transfer Table.													
Dunkirk, N. Y.	Am. Loco. Co.	1899	63—0	40—0	50—1	27—8	10—10	11—7	255	17	14—0	1 d.t., 100-ton; 1 s.t., 10-ton	One side, same bldg.
Richmond, Va.	Am. Loco. Co.	1902	66—5	No pits.	52—5	30—11	10—0	11—6	303	17	16—0	1 d.t., 120-ton; 1 d.t., 30-ton	One end, sep. bldg.
Paterson, N. J.	Rogers Loc. Wks.	1902	59—11	38—0	50—0	27—10	12—2	10—0	261	16	15—5	1 d.t., 120-ton; 1 d.t., 25-ton	One end, sep. bldg.
Reading, Pa.	P. & R.	1902	66—8	45—0	46—6	27—11	10—1	8—6	740; 740	70	20—0	1 d.t., 120-ton; 1 d.t., 35-ton.	One side, samo bldg.
Collinwood, O.	L. S. & M. S.	1902	64—2	38—0	47—0	26—3	12—1	8—8	530	23	22—0	1 d.t., 100-ton; 1 s.t., 10-ton	One side, samo bldg.
McKees' Rocks, Pa....	P. & L. E.	1903	60—2	33—0	49—1	26—3	12—1	10—9	528	20	24—0	1 d.t., 100-ton; 1 s.t., 10-ton	One side, same bldg.

TABLE 4.—HEIGHTS OF TRANSVERSE ERECTING SHOPS.

Combination 1—One level (Fig. 2); one crane, say 30 tons, to lift boilers over engines; one dummy crane, say 75 tons, to unwheel engines, but not to lift engines one over another (as at Oak Grove). Transfer table required. Height .... 40 ft.

Combination 2—One level (Fig. 2); one heavy crane, say 120 tons, to lift engines one over another (as at the Baldwin Locomotive Works). No transfer table required. Height .... 45 ft.

Combination 3—Two levels (Fig. 3); one light crane, say 10 tons; one heavy crane, say 120 tons, to lift engines one over another (as at all shops in Table 3). Height .... 50 ft.

A comparison of the dimensions of the typical longitudinal erecting shop and the three suggested alternative arrangements of the transverse erecting shop is given in Table 5.

TABLE 5.—DIMENSIONS FOR ERECTING SHOPS PER ENGINE.

Item.	Longitudinal.	Transverse. Comb'n 1.	Transverse. Comb'n 2.	Transverse. Comb'n 3.
Floor-space dimensions (in feet)	45 x 38	65 x 20	65 x 20	65 x 20
Floor-space area (in square feet)	1,710	1,300	1,300	1,300
Height to roof truss (in feet)...	40	40	45	50
Volume (in cubic feet)........	68,400	52,000	58,500	65,000

At this point it may be noted that in longitudinal shops the track pits are usually continuous, being bridged across between engines, where necessary; in transverse shops the length of pits (dimension B in Tables 2 and 3) varies greatly, but 40 ft. may be taken as a fair average. The depth of pits does not appear in the tables but has been found to average about 2 ft. 6 in. The width of pit for track of 4 ft. 8½ in. gauge comes to about 4 ft. 0 in.

Examining Table 5 it is found that the transverse shop requires less floor space than the longitudinal shop by 24 per cent., and less volume by 38, 14, and 5 per cent. for the three types respectively. The relative costs would be modified, however, by the crane equipment, and in general the crane runways of transverse shops without transfer tables have to sustain twice the load at any given point that the runways of longitudinal shops do, because the maximum load must be carried by one crane instead of by two as in a longitudinal shop. The use of dummy cranes (see foot note, Table 2), however, imposes their maximum load on crane runway posts only, while the intermediate girders have to sustain the load of the adjacent lighter crane only. The one safe basis for comparing costs is actual estimate.

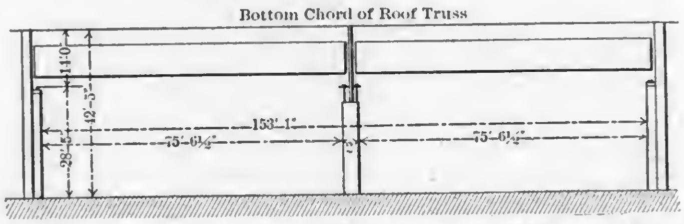


FIG. 4.—CROSS SECTION OF ERECTING SHOP. BALDWIN LOCOMOTIVE WORKS.

The relative merits of the longitudinal erecting shop and the transverse erecting shop without transfer table may be stated, in part, as in Table 6.

For very large installations a choice may be made between the longitudinal erecting shop and the transverse erecting shop without transfer table, but there are many cases of small installations where a transfer table is required for handling passenger cars, and may also be conveniently used for handling engines in and out of an erecting shop. Wherever the transfer table is used, however, to give access to a shop, efficient lighting and heating are impaired, bench or storage room is sacrificed inside the building, and yard room outside.

The output of several erecting shops of both the longitudinal and transverse types is shown by Table 7, which also shows the machine shop floor area, and the variety of work undertaken in the machine shop, as these are perhaps the two most important influences which affect the output. The number of locomotives turned out per stall per month on the ten-hour basis is the safest criterion for making comparisons, as overtime is an indefinite quantity.

Attention is called to the fine results shown for the longitudinal shops of the Pennsylvania Railroad at Altoona, and the Norfolk & Western at Roanoke, on repair work, and for the Schenectady works of the American Locomotive Company on construction work. It should also be noted that these are all comparatively old, though modern shops, and have had the

great advantage of perfecting the details of their equipment and organization, whereas the many shops built since 1900 are all still either incompletely equipped or organized. Several of the railway shops listed in Table 7 are turning out new, as well as repaired, locomotives, but in each such case the output shown in the table is that which would be, or actually has been, accomplished were no new engines being built.

Among the repair shops Altoona shows the largest machine shop floor space per erecting shop stall. The case of Roanoke is unique, as showing, apparently, a small machine shop floor space per engine. The erecting shop stands ten engines, and on that basis the machine shop floor space is 2,590 sq. ft. per engine, a comparatively high figure; but an adjacent round house, abandoned for road work, is used as an annex to the erecting shop and stands 14 engines, which are unwheeled and wheeled in the erecting shop and hauled back and forth between erecting shop and round house on special trucks. The total number of engines under erecting shop treatment being 24, the machine shop floor space is reduced to 1,079 sq. ft. per stall, which suggests that good crane facilities perhaps have quite as much influence on output as does liberal machine shop floor space. It is interesting to note that the principal construction shops follow a much more uniform practice in providing machine shop floor area per erecting shop stall than do the railway repair shops.

In considering these output figures it should be borne in mind that the cost of the work done has not been touched upon, and that it does not necessarily follow that where the output per stall is largest the cost per unit of work done is the least.

The storage of engine strippings in repair shops is not reduced to any uniform practice, and is worthy of more consideration when new shops are being designed. The use of special pits, between tracks, for this purpose, has been tried and abandoned in certain cases, but is nevertheless a feature in some new erecting shops now under construction. The indications are that a final solution of this problem will embody some proper provision of racks and bins on the floor level and closely adjacent to the engines under repairs, but not between stall tracks.

Although the longitudinal erecting shop has been credited, in the foregoing, with great flexibility of operation, yet its design is quite stereotyped; on the other hand, the transverse erecting shop, in conjunction with adjacent crane served bays, offers opportunity for a great number of variations and combinations, and it is entirely possible that the transverse type may find favor in some of the large problems of the future.

TABLE 6—LONGITUDINAL AND TRANSVERSE ERECTING SHOPS COMPARED.

Item.	Longitudinal.	Transverse.
Layout.	Can be placed parallel to general line of tracks and entered by direct track connection.	If placed parallel to general line of tracks, must be entered by turntable. If entered by direct track connection, must be placed crosswise to general line of tracks.
Structural.	Width of bays (distance between roof trusses) can be determined by conditions of economy alone.	Width of bays must be same as spread of stall tracks, whether economical or not.
Compactness (say for shop with 20 engines).	450 ft. long by 76 ft. wide. Less compact.	400 ft. long by 65 ft. wide. More compact.
Access from other shops.	Must be across the pits.	Not necessary to cross the pits.
Lighting (day and night).	More difficult.	Easier and better.
Lifting engines.	Engines have to be lifted only high enough to clear driving wheels; less time consumed.	Engines have to be lifted high enough to clear adjacent engines; more time consumed.
Moving engines horizontally.	Less distance under average conditions.	More distance under average conditions.
Dropping engines onto their wheels.	More use of cranes and less manual labor (in handling wheels).	Less use of cranes and more manual labor (in handling wheels).
Flexibility in general use of shop.	Greater.	Less.

(To be Continued.)

Mr. Arthur M. Waitt has resigned as superintendent of motive power and rolling stock of the New York Central & Hudson River Railroad. It is understood that he will take a well-earned rest after having been connected with the Vanderbilt lines for the past fourteen years.

TABLE 7—OUTPUT OF ERECTING SHOPS OF THE SEVERAL TYPES.

Place.	Railroad or Loco. Company.	Year Built.	Available Number of Stalls.	Machine Shop. Floor Space (Sq. Ft.). Total.	Machine Shop. Floor Space (Sq. Ft.). Per Stall.	No. locomotives turned out per month. Ten-hour basis. Total.	Ten-hour basis. Per Stall.	With overtime. Total.	With overtime. Per Stall.	Nature of Work for which machine-shop tool equipment is provided.
			LONGITUDINAL REPAIR SHOPS.							
Altoona, Pa., No. 1. Altoona, Pa., No. 2.	Pennsylvania. Pennsylvania.	1875 1883	18 18	120,350	3,343	115	3.19	140	3.88	Loco. repairs
Roanoke, Va.	N. & W.	1883	e. s. 10 r. h. 14	25,900	1,079	50	2.08	57	2.33	Loco. and car repairs
Burlington, Iowa ..	C., B. & Q.	1883	12	19,215	1,601	16	1.33	..	..	Loco. and car repairs
Baltimore, Md.	B. & O.	1896	30	82,756	2,759	35	1.17	..	..	Loco. and car repairs
Concord, N. H.....	B. & M.	1897	14	18,300	1,307	15	1.07	..	..	Loco. and car repairs
Elizabethport, N. J.	C. R. R. of N. J.	1902	18	31,500	1,750	25	1.39	..	..	Loco. and car repairs
Omaha, Neb.	U. P.	1902	18	42,700	2,372	22	1.22	..	..	Loco. and car repairs
Topeka, Kan.	A., T. & S. F.	1903	22	58,125	2,642	Not yet in operation				Loco. and car repairs
Jackson, Mich.	M. C.	1903	l. e. s. 14 t. e. s. 8	39,740	1,806	Not yet in operation				Loco. repairs
Montreal, Can.	C. P.	1903	36	94,500	2,625	Not yet in operation				Loco. and car repairs
Portsmouth, Ohio ..	N. & W.	1903	6	11,232	1,872	Not yet in operation				Loco. repairs
Notes.—e. s., erecting shop; r. h., roundhouse; l. e. s., longitudinal erecting shop; t. e. s., transverse erecting shop.										
			TRANSVERSE REPAIR SHOPS.							
Bloomington, Ill. ..	C. & A.		16	23,390	1,462	27	1.69	..	..	Loco. and car repairs
Burnside, Ill.	I. C.	1892	24	42,900	1,787	27	1.13	..	..	Loco. and car repairs
Depew, N. Y.......	N. Y. C.	1893	46	30,540	664	53	1.15	..	..	Loco. repairs
Brainerd, Minn. ...	N. P.	1900	25	47,465	1,898	28	1.12	..	..	Loco. and car repairs
Oelwein, Iowa	C. G. W.	1900	13	24,180	1,860	18	1.38	..	..	Loco. and car repairs
Fond du Lac, Wis..	W. C.	1900	15	21,142	1,409	..	..	..	..	Loco. and car repairs
Hannibal, Mo.	H. & St. J.	1901	10	19,272	1,927	12	1.20	..	..	Loco. and car repairs
Collinwood, Ohio ..	L. S. & M. S.	1902	23	45,580	1,982	35	1.52	..	..	Loco. and car repairs
Reading, Pa.	P. & R.	1902	70	44,400	634	69	.99	..	..	Loco. repairs
Baring Cross, Ark..	M. P.	1902	15	32,010	2,134	..	..	..	..	Loco. and car repairs
McKee's Rocks, Pa.	P. & L. E.	1903	20	52,272	2,614	Not yet in operation				Loco. and car repairs
Oak Grove, Pa....	N. Y. C.	1903	19	21,250	1,118	Not yet in operation				Loco. and car repairs
			LONGITUDINAL CONSTRUCTION SHOPS.							
Alt'na, Pa. (Juniata)	Pennsylvania.	1891	8	51,375	6,422	8.5	1.06	10	1.25	Loco. construction
			TRANSVERSE CONSTRUCTION SHOPS.							
Philadelphia, Pa. ..	Baldwin Loco. Wks.	1891	60	416,074	6,935	..	..	128	2.13	Loco. construction
Schenectady, N. Y..	Amn. Loco. Co.	1892	17	116,555	6,856	40	2.35	50	2.94	Loco. construction
Dunkirk, N. Y.....	Amn. Loco. Co.	1899	17	115,579	6,799	30	1.77	40	2.35	Loco. construction
Richmond, Va.	Amn. Loco. Co.	1902	17	56,097	3,300	18	1.06	25	1.47	Loco. construction
Paterson, N. J.....	Rogers Loco. Wks.	1902	16	93,849	5,865	20	1.25	..	..	Loco. construction

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKEES ROCKS SHOPS.—PITTSBURG & LAKE ERIE R. R.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

I.

The advantages of the individual motor drive for machine tools, particularly on tools which require a variable speed, are being demonstrated in several of the more progressive machine shops which have recently been equipped. Judging from the very satisfactory results reported with the individual drive, the amount of attention it is at present receiving and the investigations which have and are being made in order to perfect it, it seems that its use may, in the near future, become general.

It follows, therefore, that the problem of equipping old tools, or rather tools which are now in use, with individual motors promises to be a very important one, and the question naturally presents itself as to whether it will pay to thus equip tools which have not been specially designed for motor driving. At the same time, we must determine whether the design of the tool is such that when thus equipped we can make use of the better grade of tool steels which have lately been put on the market. In some cases it will be found that the construction of the tool is so light or so badly designed that it will be impossible to take advantage of the larger cuts or the higher cutting speeds which these new tool steels permit.

The question as to whether it will pay to thus equip a machine will of course depend upon several considerations, such as the particular system of individual drive which is to be used, the design of the machine, the work it will be required to do, the range of speed desired, etc. In most cases, if the machine is in good shape and the nature of the work and the conditions such that the close speed regulation thus afforded can and will be used to advantage, it will probably pay to change it; but no general rule can be laid down, and it will be found necessary to carefully consider each machine by itself.

As an illustration, it was found, in considering the application of a motor drive to a certain machine, that the speed as driven by a belt was such that on certain grades of work considerable time was necessarily lost on account of not having a variable speed and a close speed regulation. The cost of changing this to an individual motor-driven tool and in changing certain parts of the running gear, in order to make them strong enough to take advantage of a better tool steel, seemed excessive. Upon ascertaining the price of a new machine that would do similar work, however, it was found that it would be a decided advantage to fit up the old tool, which was otherwise in good condition and which would, when thus fitted up, be practically as good as a new machine.

In some cases, all that will be required will be the necessary electrical apparatus and the gears, or silent chain, to connect the motor to the machine. Others may require brackets for the motors, new runs of gearing, stronger running parts, or new means of driving the feed mechanism, lubricating pumps, or hoists. Fly-wheels may have to be used on planers, shapers or slotters to protect the motor from the sudden heavy shocks due to reversal. Where new runs of gearing are added, clutches, or some means of throwing the gear in and out, will need to be provided.

In planning for their new shops at McKees Rocks the Pittsburg & Lake Erie Railroad have just completed designs for equipping about thirty of their present belt-driven machines with Crocker-Wheeler Company motors for individual driving, using the four-wire multiple-voltage system. The purpose of this article will be to show how these designs were worked up and to consider in detail some of the changes made.

In these shops the individual motor drive will be used almost exclusively for the machine tools, except on the very light machines, and in order to bring out more clearly some questions of design, which will be treated later, it might be well to briefly consider the reasons which influenced the management to take such a radical step from ordinary railroad shop practice.

First.—The most important reason was the advantage to be gained by closer speed regulation. We find that on most of the belt-driven tools the average increase of speed per step is about 50 per cent. For instance, the spindle speeds might run as follows: 10, 15, 23, 35, 53, 70, etc. It was found by closely watching the work on these machines that while in many cases the speed was evidently too low for a given piece of work, yet the increase of speed to the next step was so great that the tool steel could not stand it. The controller to be used in these shops is such that the average increase of speed per step will be about 10 per cent., i. e., 10, 11, 12.1, 13.3, 14.6, 16.1, etc. It will therefore be seen that the output per machine and therefore per man should be considerably increased, since it will be possible to more nearly approach the working limit of the tool steel. In the ordinary shop, the labor item is the *largest single item* of expense, and the saving of a small per cent. of a man's time will amount to quite an item at the end of a year.

Second.—It permits of great ease of speed regulation. The controller can be placed at the most convenient point, or, if advisable, two or more handles can be provided at different parts of the machine. In the case of a lathe, the handle can be arranged to travel with the tool carriage. With the belt-driven machine more or less time is always lost in throwing a belt, and a negligent operator will not always take advantage of a change of speed on account of the exertion required to make the change.

Third.—It allows head room for cranes. A traveling crane can be used to great advantage in a railroad machine shop, particularly for serving the larger machines.

Fourth.—Increased light and cleanliness results. Upon entering the machine and erecting shop of the Lake Shore & Michigan Southern Railway at Collinwood one of the most noticeable features is that part of the shop which is occupied by individual motor-driven tools. For a moment or two it is hard to realize you are really in a machine shop, the contrast with some of our older shops being so great. With plenty of light and the absence of dust and dirt caused by shafting and belts, a workman surely ought to be inspired to do better and more efficient work.

Fifth.—The machines can be placed to the best possible advantage, and if it should be necessary to rearrange them it can readily be done.

Sixth.—If it is necessary to work a few machines overtime a lot of power will not be wasted in running a shop full of shafting.

Seventh.—When a machine is not running it is not using any power, whereas, in a belt-driven shop the shafting is always running. Experiments have demonstrated that in an ordinary machine shop the shafting requires as much or more power than the average power required to run the machines. Of course the loss of power in transforming the mechanical energy into electrical, carrying it from the power house to the machine tool and re-transforming it back into mechanical energy to some extent offsets this, but the efficiency of the generator and motor is quite high and these losses are not nearly as great as those involved in the use of shafting.

Eighth—Additional tools can readily be added to the equipment.

Ninth—The absence of shafting simplifies the construction of the building.

To partially offset these advantages we find the following disadvantages:

First.—Greater first cost; and

Second—Depreciation is greater and motors require more attention. (This item should not amount to much, however, as the motors are now made in a very substantial manner and require very little attention.

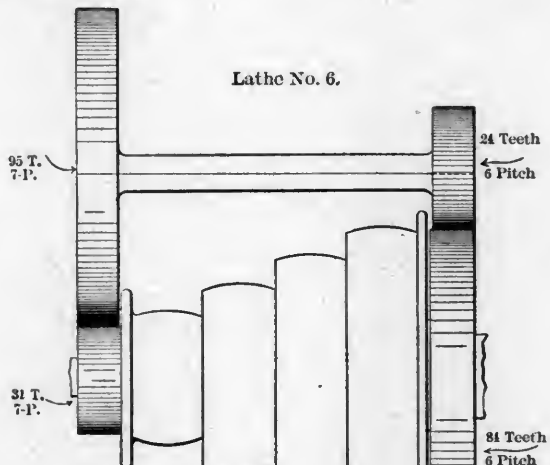
The expense of training the men to take advantage of the closer speed regulation must also be considered, for it is here that the greatest gain over the old system is to be made. While no definite plans have as yet been adopted, this diffi-

culty will probably be met in the following manner: A plate will be placed on each machine to show the different spindle speeds for each position of the controller handle with each run of gears, if there is more than one run. As soon as the machines are installed in the shop a careful set of tests will be made to determine as closely as possible the working limits of the tool steel on each of the different classes of work to be done on each machine. These results can, of course, only be approximate. The Crocker-Wheeler Company, in a series of tests at their works, found that the horse-power required on the same piece of work varied as much as 30 per cent., depending on the shape of the cutting tool and the sharpness of its edge. This difference can probably be overcome to a large extent by grinding the tools on a universal grinder. The difference in the chemical composition and the physical characteristics of the same kind of material is such that the results to be gained by these tests will probably vary considerably; but by planning the work according to the average results we ought to approach very much nearer the working limit of the tool steel than with the present system of drive. The serious part of the problem will be to work up this information in such shape that the operator of a machine, who may not be a man of great intelligence, can easily grasp it and may know what cutting speed to use on a given piece of work. We expect to overcome this by drawing up a series of tables which will be simple and easily understood.

To those wishing to more fully investigate the questions involved in the use of individual motors, the following references may be of interest:

"The Requirements of Machine Tool Operation, with Special Reference to the Motor Drive." By Charles Day; paper read before New York Electrical Society, December, 1902. "The Power Question—Locomotive Repair Shop." By R. W. Stovel; paper read before the Railway Club of Pittsburg, February, 1902. "Electric Equipment in Modern Machine Shop Practice." By F. B. Duncan; paper read before the Engineers Society of Western Pennsylvania, May, 1902. "Continuous Current Motor for Machine Tools." By F. O. Blackwell; paper read before the American Institute of Electrical Engineers, November, 1902.

Upon undertaking the work of drawing up plans for changing the machines to take motors, we found very little information on file as to the runs of gearing and the spindle speeds of the different machines. The first step, therefore, was to get together this data. At the same time, each machine was given a number for convenience in handling sketches, drawings and correspondence. The following shows this data for one of the machines:



DATA FOR LATHE NO. 6.

Spindle Speeds.	R. P. M.
Minimum—Back gear in	6½
Maximum—Back gear in	41
Minimum—Single gear	69
Maximum—Single gear	438

31-95 × 24-84 = 1-10.7 back gear ratio.

The next step was to determine the new range of speeds desired, and it was decided to base these on a tool steel which would take a heavy cut at 50 or 60 ft. per minute. The minimum speed on a machine cutting various diameters would therefore be for the heaviest cut on the largest diameter, while the maximum speed would be for a light cut or for filing on the smallest diameter of work. In the case of such machines as shapers and slotters it was not so much a matter of what the tool steel would stand as the speed the machines themselves would stand, and this was determined by running the machines at the maximum speed with the belt and roughly estimating how much more they would stand. A number of experiments were made on the machines by taking large cuts at as high speeds as possible to see how they would stand up. Some of them appeared too light and it was decided not to fit them up. A number of tests were also made with Mushet steel to get some idea of its limitations. Following are a few examples of the above series of tests, which, while not of especial value, may be of interest:

Machine.	Tool Steel.	Depth of Cut.	Feed.	No. of Tools Cutting.	Material.	Diam. of Work.	Cutting Speed Per Min.	Time Tool Lasted.
		In.	In.			Ins.	Ft.	
Boring mill	Mushett	¼	3-32	2	Steel tire	44	24	2 rev.
Axle lathe	Mushett	¼	⅛	2	Steel axle	...	52	......
Wheel lathe	Mushett	5-16	1-12	2	Steel tire	...	15	4 min.
Lathe No. 9	Mushett	¼	1-16	1	Steel crank pin	6¼	36	20 rev.
Lathe No. 10	Mushett	¼	3-32	1	Steel crank pin	6¼	42	13 rev.
Lathe No. 6	Mushett	3-16	1-36	1	Steel crank pin	6¼	72	36 rev.
Lathe No. 11	Mushett	¼	1-18	1	Steel crank pin	6¼	32	18 rev.
Lathe No. 18	Mushett	¼	1-32	1	Steel crank pin	6	62	31 rev.
Lathe No. 19	Mushett	¼	3-64	1	Steel crank pin	5¾	34	12 rev.
Lathe No. 8	Mushett	3-16	1-32	1	Steel crank pin	5¾	36	32 rev.

McKees Rocks Shops, 8-18-'02.

Having determined the range of speed and the maximum cuts to be taken on each machine, the next question to be considered was the amount of power it would require. Tests have shown that the horse-power required depends practically on the amount of metal removed per minute.

The Crocker-Wheeler Company, with this as a basis, have devised the following formula for finding the horse-power required for a given cut:

H.P = feed × cut × cutting speed per minute in inches × number of cutting tools × a constant.

An extensive series of tests made by them shows the value of this constant to be from .35 to .5 for cast iron and from .45 to .7 for steel, depending on the hardness of the material. For instance, considering the fourth case in the above table we have:

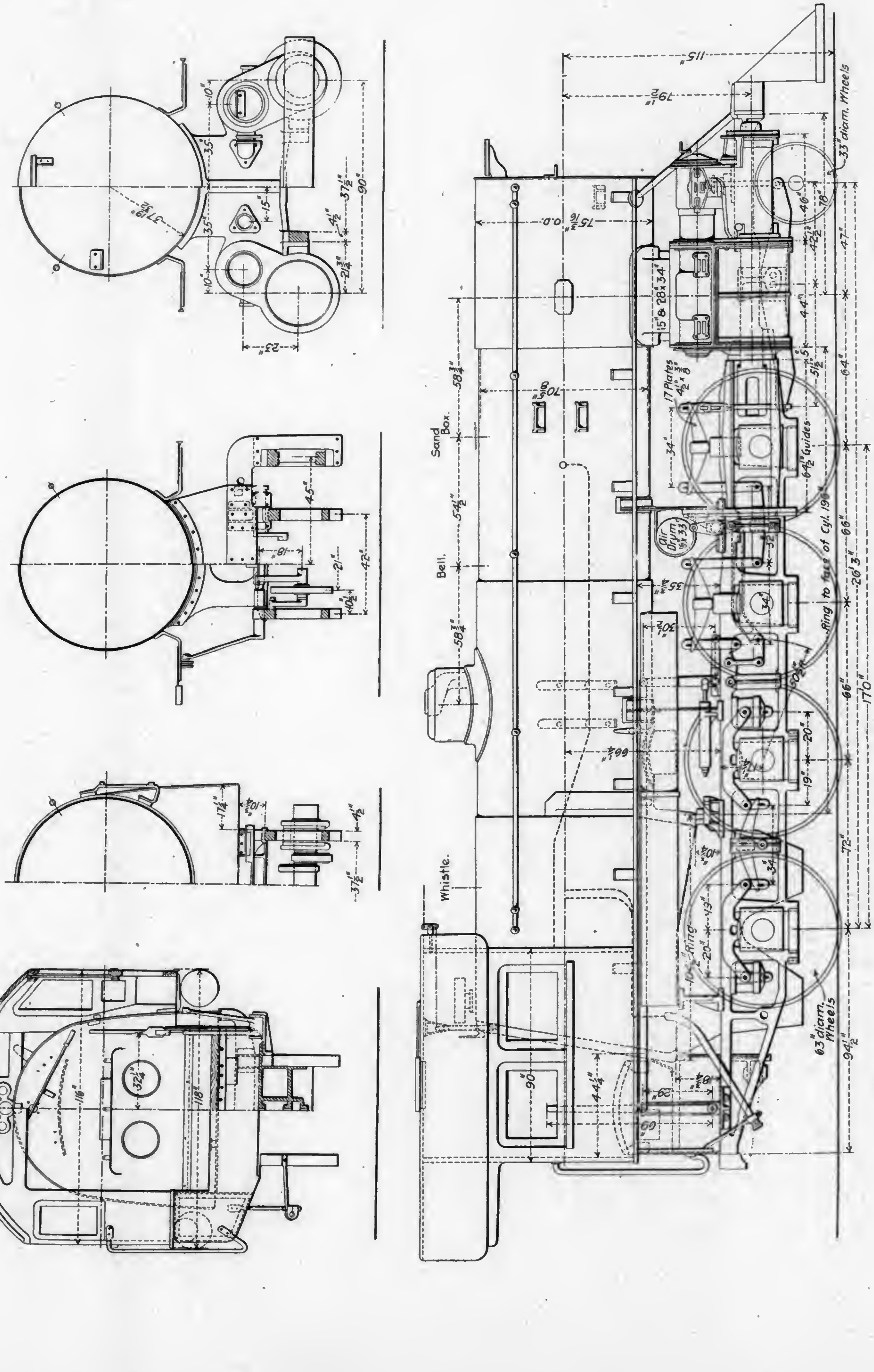
$$1/16 \times \frac{1}{4} \times 36 \times 12 \times 1 \times .7 = 4.7 \text{ H.P. (Maximum)}.$$

For turning steel tires we arbitrarily assumed that the constant would be 1, since this steel is very hard.

(To be continued.)

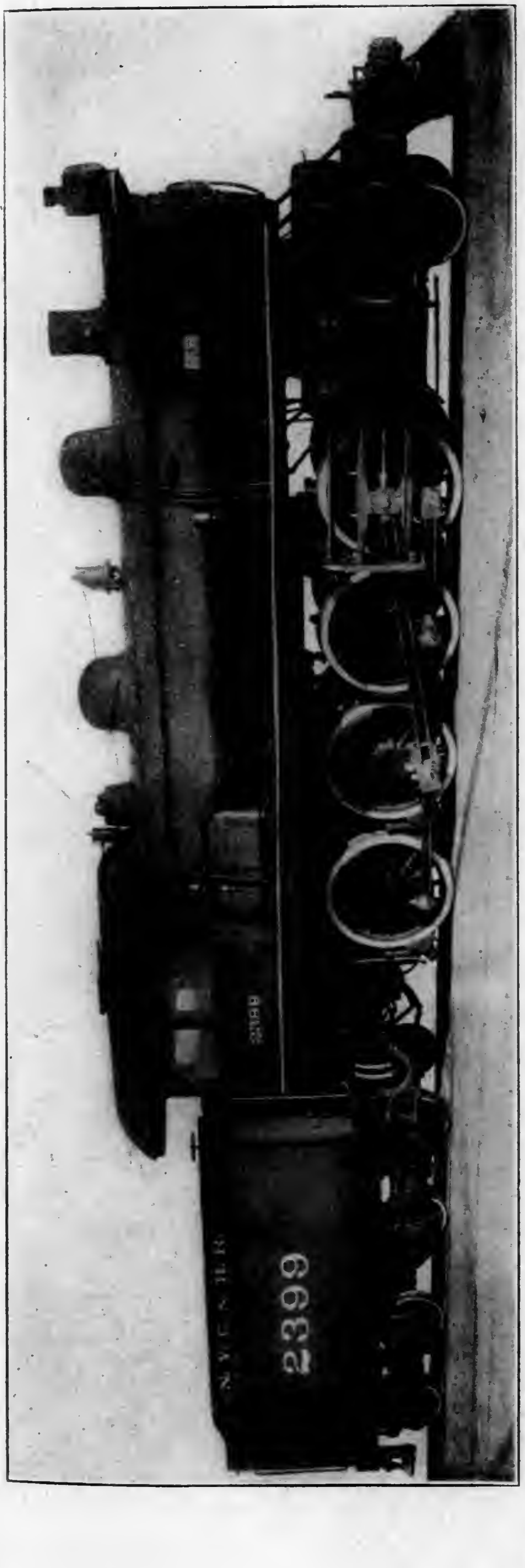
The high-speed steam railway competition, which was inaugurated about a year ago by the German Society of Mechanical Engineers, has resulted in no prizes being awarded, five of the plans submitted only being given honorable mention. It is now under consideration to submit a closed competition between the five more successful engineers under specifications of a more practical nature. In the last year's competition it was specified that the steam locomotives were to be designed to be powerful enough, and to be capable, with the cars, of withstanding the high speed of 90 miles per hour, a train speed which has been thoroughly demonstrated both here and abroad to be far beyond the limits of possibility imposed by the track and road-bed conditions of the best railway lines.

The limit of high-speed operation of machine tools is not determined by the cutting tools, or by the ability of the drive to vary its speed and pull the cut, but is to be found in the stability of the machine itself. Machine tools have been designed much too light in the past to withstand the duty imposed by modern methods of operation, as with the Novo, Taylor-White, and other high-speed tools cutting speeds ranging from 40 to 100 ft. per minute have been rendered practicable, whereas 10 to 20 ft. per minute was formerly considered "good practice."



EXPERIMENTAL TANDEM COMPOUND FREIGHT LOCOMOTIVE.—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*



EXPERIMENTAL TANDEM COMPOUND FREIGHT LOCOMOTIVE.
2-8-0 TYPE.
NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

AMERICAN LOCOMOTIVE CO., SCHENECTADY WORKS, *Builders.*

A. M. WAITT, *Superintendent Motive Power.*
J. F. DEEMS, *General Superintendent Motive Power.*

EXPERIMENTAL TANDEM COMPOUND FREIGHT LOCOMOTIVE.

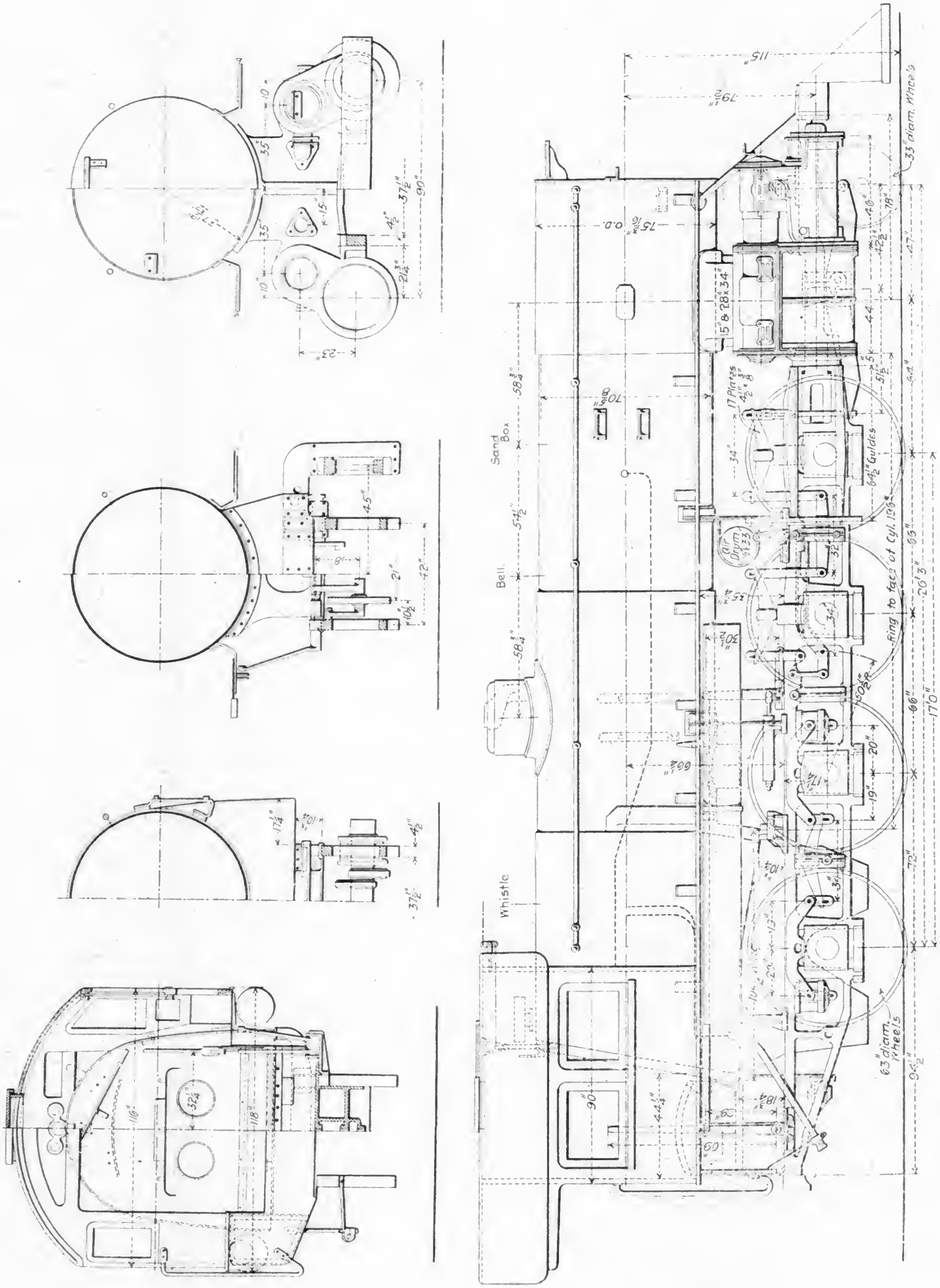
2—8—0 TYPE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

About four years ago this road began a policy of building heavier locomotives, although its grades are, as a rule, very light. The capacity has increased with every new design in freight service, but the advance has been very gradual. This road rates its engines on a percentage basis, a 100 per cent. engine being one with a drawbar pull of 100,000 lbs. Of course, this figure will never be reached and the rating need never be disturbed or changed. Early in the year 1901 a number of 2—8—0 type engines were built for this road (AMERICAN ENGINEER, March, 1901, page 83), which were rated at 38.5 per cent. on this basis. These were designated Class G-1, and were soon followed by Class G-2 of the same wheel arrangement, but with the dimensions and weights given in the table which appeared in the inset with the June, 1902, number of this journal. This class is rated at 39.1 per cent., and 66 of them are now in service. These are all two-cylinder Schenectady compounds, and are able to haul 4,000 tons of coal in trains of 90 cars between Buffalo and Albany with help at the heaviest grades. They are not used between Albany and New York. The limits for trains on this road, however, is 3,000 tons or 80 cars. This design was another step toward heavier and more powerful engines, and as the 35-in. low-pressure cylinder of the Class G-2 was considered the limit for the two-cylinder compound for this road it was decided that the tandem cylinder arrangement offered the most favorable opporunity for an increase in capacity. Instead of trying the tandem experiment on a large scale, another of the G-2 class was built exactly like the others, except in the details involved in the use of tandem cylinders. This is known as Class G-2 A, and as it is a step toward a much heavier and more powerful design of this type it is placed on record here. Careful and systematic progress in increasing capacities of locomotives, particularly with new types of this character, is commendable, and the larger engines constituting the next advance will be more successful because of the experience with this experimental engine. The next class, G-4, will have 16 and 30 x 30 in. tandem cylinders, and the weight on driving wheels will be about 200,000 lbs.

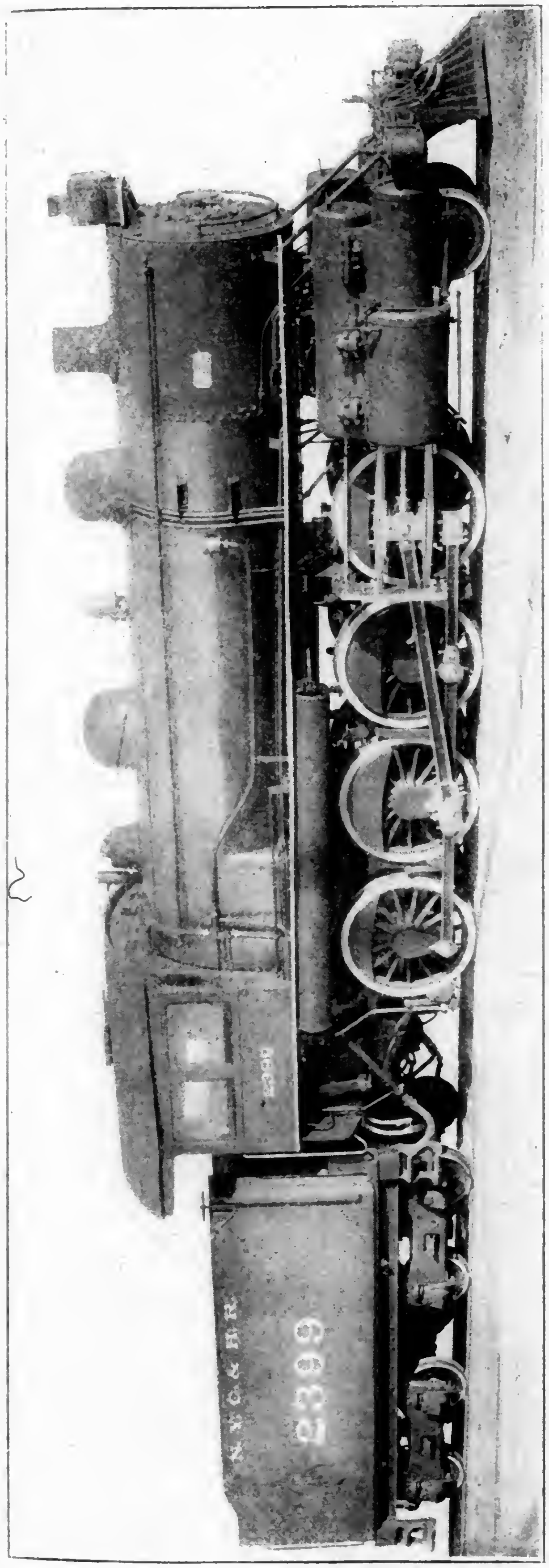
The experimental engine is an adaptation of Class G-2, it has the same boiler and running gear, and the cylinders and valves follow the plan of the first Schenectady design of tandem compound for the Northern Pacific (AMERICAN ENGINEER, September, 1901, page 271), the cylinder being the same size as those of the Northern Pacific. The same form of metallic sleeve is used for the piston rod where it passes through the head between the high and low pressure cylinders, and the valve for converting from compound to simple and the reverse is the same in principle as the earlier form operated by a rod from the cab. This valve is shown in one of the illustrations. The cylinders, however, have undergone a marked change, which seems to be a decided improvement. Instead of a double-bar frame at the cylinders a single 10-in. slab is used and the stresses are brought as nearly as possible from the center of the cylinder to the center of the frames. This permits of avoiding tortuous steam passages and the cylinder structure is not weakened, as it has been sometimes, to provide for a double-bar frame. Furthermore, the cylinder fastenings may be made stiffer and stronger. This appears to be a most important improvement. A number of interesting details will be brought out in connection with the new and heavier class which is soon to be built.

Experience with this experimental engine has been satisfying in every respect, but it has been thought desirable to provide for automatic lubrication of the piston-rod sleeve between the cylinders. On the new engines this will be done. The indicator cards shown are interesting because they exhibit the effect of the absence of a receiver on the tandem engine.



EXPERIMENTAL TANDEM COMPOUND FREIGHT LOCOMOTIVE.—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

American Locomotive Company, Schenectady Works, *Builders*.



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2-8-0 TYPE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

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They are presented in comparison with cards from one of the G-2 class.

For convenience in comparison the following ratios have been worked out for the experimental engine:

$$\frac{\text{Heating surface}}{\text{Volume H. P. cylinders}} = \frac{3,480}{6.8} = 511$$

$$\frac{\text{Adhesive weight}}{\text{Heating surface}} = \frac{172,500}{3,480} = 49.57$$

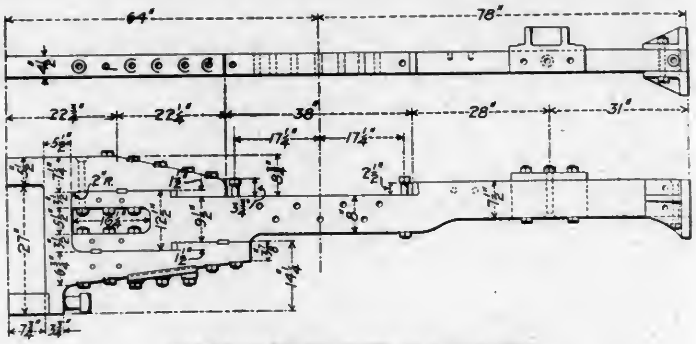
$$\frac{\text{Adhesive weight}}{\text{Tractive effort}} = \frac{172,500}{39,100} = 4.4$$

$$\frac{\text{Tractive effort}}{\text{Heating surface}} = \frac{39,100}{3,480} = 11.2$$

$$\frac{\text{Heating surface}}{\text{Grate area}} = \frac{3,480}{50.3} = 69$$

$$\frac{\text{Tractive effort} \times \text{diameter of drivers}}{\text{Heating surface}} = 707$$

Last summer a series of test runs were made in freight service to compare one of the cross compounds with the tandem, the engines being alike except for the system of compounding. In the accompanying record No. 2399 is the tandem and No. 2374 the cross-compound. Helper engines were used out of DeWitt and on other grades. Five water stops were made



FRAME CONSTRUCTION AT CYLINDERS.

on each trip. Water meters were used to record the amount of water used. Finely broken bituminous coal was used and the same quality was used for both engines. It was weighed on platform scales at both terminals. Both engines had the same size exhaust nozzle, 5¼ ins. The boiler performance of the tandem was lightly better than that of the cross-compound, but the coal record per ton-mile was slightly in favor of the cross-compound; the difference, however was not sufficient to be of importance. Indicator cards are shown for both of the engines.

ROAD TEST OF LOCOMOTIVES NOS. 2399 AND 2374—MOHAWK DIVISION. FREIGHT SERVICE.

Date.	Locomotive No.	Trip.	No. of Cars. With Caboose.	Distance Hauled, Miles.	Weight of Cars, Tons	Ton-Miles	Coal per Ton-Mile, Lbs.	Water per Ton-Mile, Lbs.	Total Coal Per Trip, Lbs.	Total Water per Trip, Lbs.	Water Evap. per Lb. Coal, Actual Lbs.	Water Evap. per Lb. Coal from and at 212° F., Lbs.	Average Steam Pressure.	Aver. Temp. Feed-Water, Degrees.	Time on Road. hrs. min.	Time Standing. hrs. min.	Actual Running Time. hrs. min.	Aver. Speed While Running, Miles per Hr.	No. Full Stops.	Av. Lbs. Coal per Sq. Ft. Grate per Hour while Running.
July 29, '02	2399	DeWitt to West Albany	72	139	3217	447163	.0429	.3093	19179	138340	7.21	8.4	182.3	65	11 53	2 13	9 40	14.4	12	39.1
July 31, '02	2399	DeWitt to West Albany	{79 1	139 62	3229 60	453451	.0459	.3158	20840	143210	6.87	8.23	184	72.5	11 7	1 51	9 16	15.4	9	44.7
Average..	2399	DeWitt to West Albany	74	......	3231	449107	.0444	.3166	20009	141877	7.04	8.36	183	67.5	12 26	2 24	10 2	14.08	11	42.9
Aug. 4, '02	2374	DeWitt to West Albany	76	140	3221	449540	.0434	.3056	19496	137400	8.05	8.5	189	71.86	12 3	2 37	9 26	14.9	17	41.2
Aug. 6, '02	2374	DeWitt to West Albany	80	139	3136	435904	.0434	.3092	18930	134784	7.12	8 7	177	71.3	12 30	2 43	8 47	15.8	10	43.2
Aug. 8, '02	2374	DeWitt to West Albany	{65 1	139 15	3165 58	440805	.0436	.3185	19230	140400	7.30	8.39	178.3	67	12 34	2 54	9 40	14.4	15	37.4
Average ..	2374	DeWitt to West Albany	74	......	3173	441565	.0435	.3111	19219	137528	7.16	8.53	181.4	70	12 32	2 45	9 18	15.0	14	40.6
		SUMMARY. AVERAGE RESULTS.																		
....	2399	DeWitt to West Albany	74	......	3231	449107	.0444	.3166	20009	141877	7.04	8.36	183	67.5	12 26	2 24	10 2	14.08	11	42.9
....	2374	DeWitt to West Albany	74	......	3173	441565	.0435	.3111	19230	137528	7.16	8.53	181.4	70	12 32	2 45	9 18	15.03	14	40.6
% Difference Based on 2399	....	....	....	....	....	1.7%	2.0%	1.7%	3.8%	3.1%	1.7%	2.0%	0.87%	3.7%	0.8%	14.6%	8.9%	6.7%	2.7%	5.3%

NO. 2374—CROSS COMPOUND.

Card No.	R. P. M.	Train Velocity, Miles per Hour.	Reverse Lever Notch.	Throttle.	Boiler Pressure.	M. E. P. H. P. Average.	M. E. P. L. P. Average.	I. H. P. H. P.	I. H. P. L. P.	I. H. P. Total.
1*	42	7.93	3	Full	165	139	58.65	408.65	402.6	811.25
3*	48	9.06	5	Full	195	144.8	42.3	486.5	331.85	818.35
11	124	23.43	17	Full	175	53.2	33.6	461.75	579.5	1041.25

Freight service, August 8, 1902.
DeWitt to West Albany, 139 miles.
Time on road, 12 h. 30 m.
Time standing, 2 h. 43 m.

Actual running time, 8 h. 47 m.
Average speed, 15.8 m. p. h.
Number of cars, 80.
Weight of train, 3,136 tons.

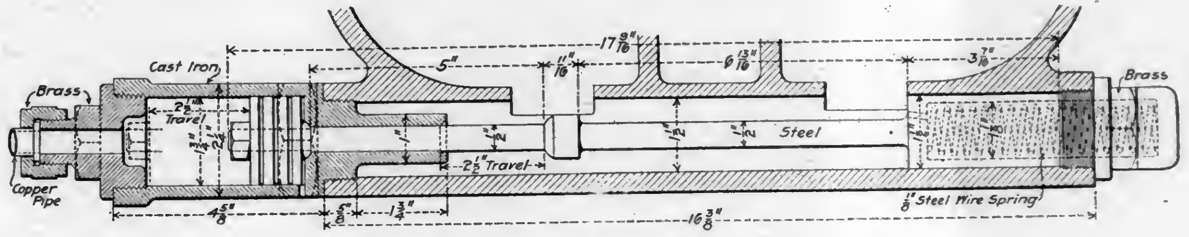
*Cards 1 and 3 taken with engine working simple.

NO. 2399—TANDEM COMPOUND.

Card No.	R. P. M.	Train Velocity, Miles per Hour.	Reverse Lever Notch.	Throttle.	Boiler Pressure.	M. E. P. Left Cylinders. H. P. Average.	M. E. P. Left Cylinders. L. P. Average.	I. H. P. Left Cylinders. H. P. Average.	I. H. P. Left Cylinders. L. P. Average.	I. H. P. Left Cylinders. Total.	Total I. H. P.
2	72	13.60	10	Full	192	126	43	269.75	325.55	595.30	1190.60
10	108	20.41	19	Full	180	84.2	24.5	270.4	278.7	549.1	1098.2
Card Taken from Test of July 31, 1902.						Engine Working with "Starting" Valve Open.					
14	72	12.96	14	Full	194	62.2	49.1	133.15	371.61	504.76	1009.95

Freight service, July 29, 1902.
DeWitt to West Albany, 139 miles.
Time on road, 11 h. 53 m.
Time standing, 2 h. 13 m.

Actual running time, 9 h. 40 m.
Average speed, 14.4 m. p. h.
Number of cars, 72.
Weight of train, 3,217 tons.



SECTION THROUGH STARTING VALVE.

Experimental Tandem Compound Freight Locomotive.
2—8—0 Type.
New York Central & Hudson River Railroad.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	200,000 lbs.
Weight on drivers	172,500 lbs.
Weight engine and tender in working order	308,000 lbs.
Wheel base, driving	17 ft.
Wheel base, rigid	17 ft.
Wheel base, total	26 ft. 3 ins.
Wheel base, total, engine and tender	54 ft. 3 ins.

Cylinders.

Diameter of cylinders	15 and 28 ins.
Stroke of piston	34 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	High-pressure, 3 ins.; low-pressure, 4 ins.
Kind of piston packing	Plain rings
Kind of piston-rod packing	Metallic

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Steam lap of slide valves	1 in.
Exhaust clearance of slide valves	High-pressure, line and line; low-pressure, ¼ in.
Lead of valves in full gear	Line and line
Kind of valve-stem packing	Metallic

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	63 ins.
Material of driving wheels, centers	Cast steel
Thickness of tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	Main, 9½ ins. diameter; others, 9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals	7½ x 5¼ ins.; 6½ ins. diameter x 6 ins.
Diameter and length of side rod crankpin journals	5 ins. diameter x 3¾ ins.
Engine truck, kind	Two wheel, swing-bolster
Engine truck, journals	6¼ ins. diameter x 10 ins.
Diameter of engine-truck wheels	33 ins.

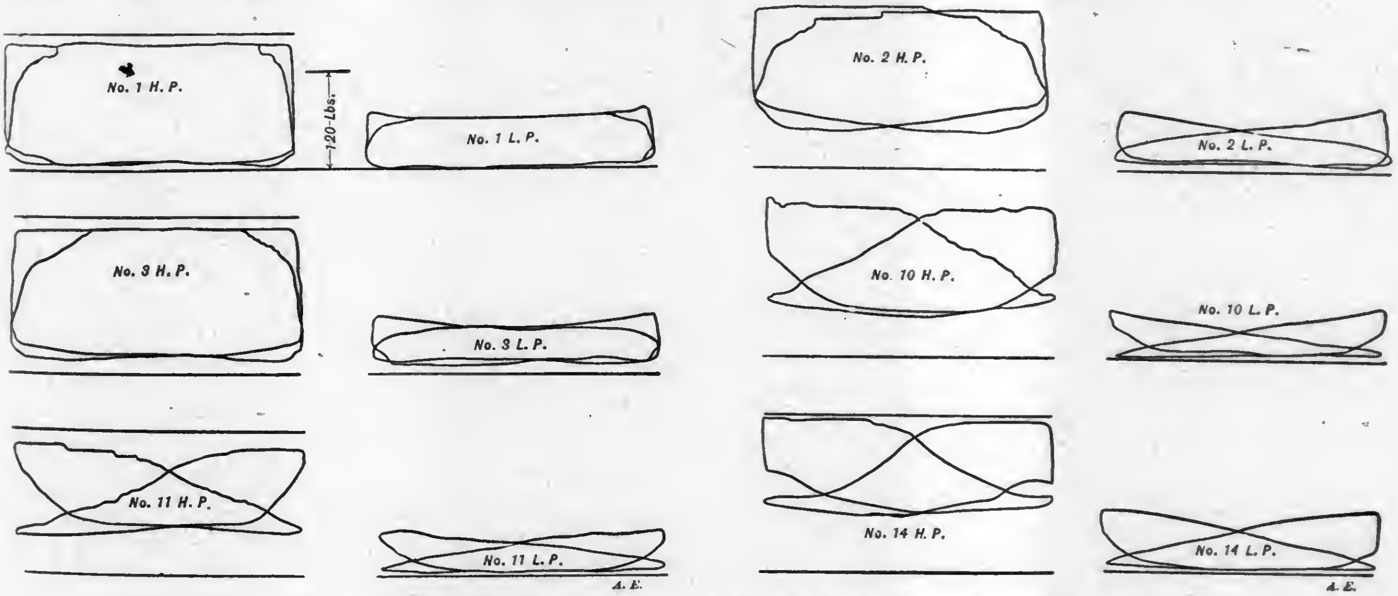
Boiler.

Style	Straight, with wide firebox
Outside diameter of first ring	72⅛ ins.
Working pressure	210 lbs.
Thickness of plates in barrel and outside of firebox	25-32, ½, 13-16, 1, ⅝ in.
Firebox, length	96⅛ ins.
Firebox, width	75⅜ ins.
Firebox, depth	Front, 73 ins.; back, 63 ins.
Firebox plates, thickness	Sides, 5-16 in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	4 ins. and 5 ins. front, 3½ ins. and 5½ ins. sides, 3½ ins. and 4½ ins. back
Firebox, crown staying	Radial stays, 1⅛ in. diameter
Firebox, staybolts	1 in. diameter
Tubes, material and gauge	Iron, 12 B. W. G.
Tubes, number	396
Tubes, diameter	2 ins.
Tubes, length over tube sheets	(16 ft.) 192 ins.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,298.08 sq. ft.
Heating surface, water tubes	27.09 sq. ft.
Heating surface, firebox	155.40 sq. ft.
Heating surface, total	3,480.57 sq. ft.
Grate surface	50.32 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5 ins., 5¼ ins., 5⅜ ins. diameter
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 9 ins.
Boiler supplied by	Two injectors, No. 10

Tender.

Style	8-wheel
Weight, empty	44,750 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	16 ft. 6½ ins.
Tender frame	10-in. steel channels
Tender trucks	Fox pressed steel
Water capacity	5,000 U. S. gallons
Coal capacity	10 tons

Brake—Westinghouse-American Combined on all drivers on tender and for train. 9½-in. L. H. air pump. Two main reservoirs, 16 x 126 ins.



INDICATOR CARDS FROM CROSS-COMPOUND AND TANDEM LOCOMOTIVES.

Purdue University has recently been the recipient of liberal treatment at the hands of its State legislature, just adjourned. By an amendment to a previously existing law, the income of the university has been increased from a twentieth of a mill to a tenth of a mill upon the assessed value of the State. The increase is about $65,000, which brings the university's annual income from all sources considerably above $200,000. The legislature also made specific appropriations amounting in round numbers to $150,000, out of which is to be provided a central heating plant and a building for the department of physics.

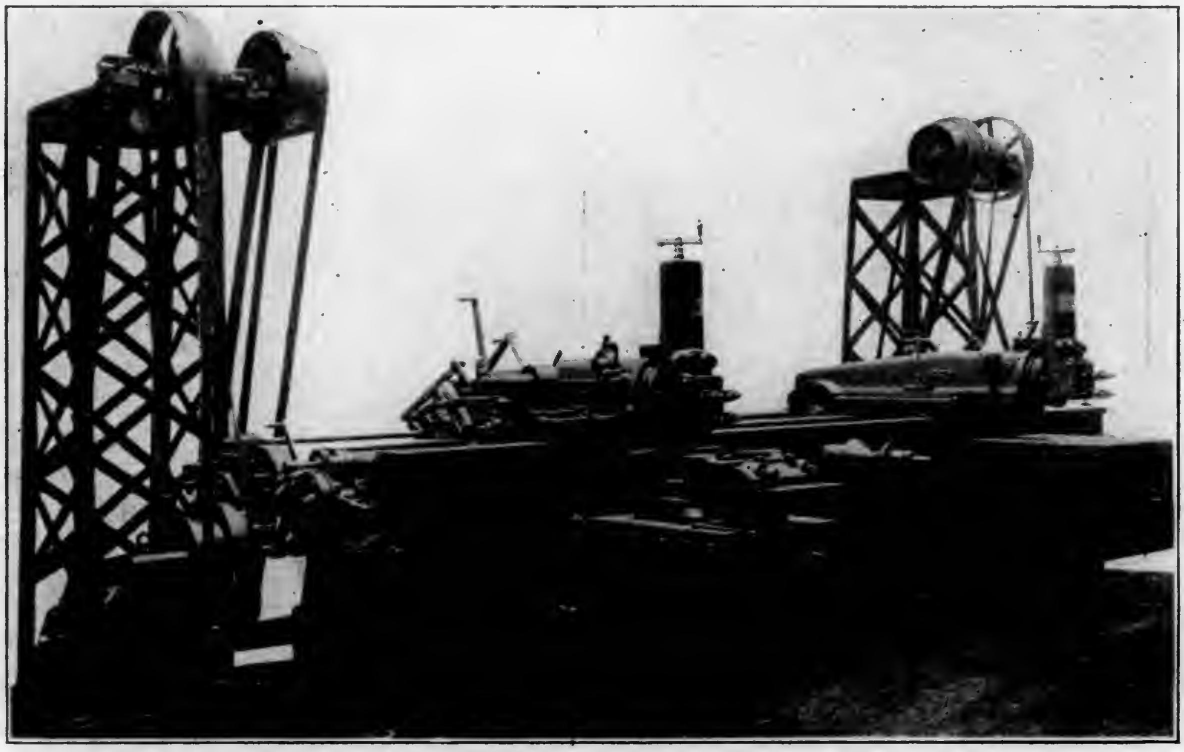
The Pennsylvania Railroad Company contemplates the construction of a bridge crossing Long Island Sound by the way of the Hell Gate channel and Ward's and Randall's Islands, so as to give its recently acquired Long Island system connection with the N. Y. C. and the N. Y., N. H. & H. Railroads reaching the New England States.

POWER TEST OF AN ELECTRICALLY-DRIVEN SHAPER.

CINCINNATI SHAPER COMPANY.

A very important advantage is gained from the individual-drive method of electrically operating machine tools by reason of the facility offered for easily and accurately measuring, electrically, the power required for various machining operations. The expenditures of power required for all variations in cuts and feeds may be readily determined as voltmeter, and ammeter readings can be taken of the current demanded by the motor while the cut is under way.

An interesting power test was recently made in this way by the Cincinnati Shaper Company, Cincinnati, Ohio, upon a large double-head motor-driven traverse shaper, which had been arranged especially for motor driving by the application of an independent motor for the drive of each head. The accompanying engraving presents a general view of this tool thus equipped, the motors used for the two drives being each of the constant-speed type. Both motors were of 5-h.p. capacity, made by Jantz & Leist, of Cincinnati, and arranged to operate upon a 500-volt, direct-current circuit. They are each mounted upon an independent base at the end of the machine, which carries a strong, lattice-braced steel superstructure for the support of the countershaft.



36-INCH DOUBLE-HEAD MOTOR-DRIVEN TRAVERSE SHAPER.—CINCINNATI SHAPER CO.

USED IN THE POWER TEST WITH VARIOUS FEEDS.

Each motor is belted direct to its countershaft through a pair of four-step cone pulleys, from which countershaft are run the two belts necessary for the slow forward and the quick return motions for the ram. The control of each motor is through a knife switch and a starting rheostat, located upon the end of the shaper's bed and protected from metal chips and dirt by hood.

This shaper is of a new design, each ram of the tool having a stroke of 36 ins. and independently driven through steel gearing and racks of extra strength. A notable feature is the double-gibbed arrangement of staying the ram saddles to the bed, in order to properly resist the stress due to the very heavy cuts resulting from the use of the new high duty tool steels; besides the usual gibbing of the saddle to the front side of the bed there is also a taper gib underneath the saddle bearing against the front edge of the back member of the bed, thus dividing the thrust between the two top members of the bed instead of concentrating it at the front edge.

The object of the test was to determine by the above mentioned electrical method the actual amount of power required for driving the machine during a machining operation in which the feeding ratio only was varied regularly. The work machined during the test was a piece of cast iron of close grain, but of medium hardness. A uniform depth of cut was used throughout, the feed being varied by 1-16 in. in the different tests.

The motor operated at a speed of 1,050 revolutions per minute, while the ram was geared to travel at a rate of 20 ft. per minute on the forward stroke and of 65 ft. per minute on the return stroke. Voltmeter and ammeter readings were taken while the tool was cutting, fifteen or twenty readings being taken for each rate of feed, and from these results averages were calculated, which were considered to represent very closely the result of the uniform conditions for each rate. This was particularly necessary because the voltage of the motor supply current varied from 480 to 550. From these average values of the voltage and current, the power used by the motor was calculated in horse-power, as indicated in the following table:

POWER REQUIRED AT THE MOTOR.

Motor, running light, driving countershaft and pulleys on machine, only	1.66-H.P.
Gross power required to drive the machine running light, during forward motion of ram	2.38-H.P.
Net useless power absorbed by forward motion of ram at approximately 20-ft. per minute	.72-H.P.
Gross power required to drive the machine running light, at instant of reverse of ram	7.71-H.P.
Net useless power absorbed during reverse motion of ram at approximately 65-ft. per minute	6.05-H.P.
Power required at the motor with the tool cutting at the constant depth of 29-32-in., but with varying feeds:	
For a feed of 3-64-in.—gross	5.52-H.P.
For a feed of 3-64-in.—net	3.14-H.P.
For a feed of 4-64-in.—gross	6.11-H.P.
For a feed of 4-64-in.—net	3.73-H.P.
For a feed of 5-64-in.—gross	7.14-H.P.
For a feed of 5-64-in.—net	4.76-H.P.
For a feed of 6-64-in.—gross	8.61-H.P.
For a feed of 6-64-in.—net	6.23-H.P.

The actual proportions of the cut taken by the tool during the tests is indicated by the sketch above the accompanying diagram at the right; the depth of cut was maintained constant at 29-32-in. throughout the tests. The diagram is arranged to present graphically the relation of the increase of power demanded by the motor to the increase of cut due to the increased rate of feed. The four full vertical lines at the middle are drawn to a scale to represent the net power required at the tool with the various feeds, the percentage of increase of power required in each case over that demanded for the previous feed being indicated at the top of each line. It may be noticed that the variation in the power required becomes much greater as the feed grows heavier and more metal is removed per stroke; this is undoubtedly due to the increased size of chip and its attendant difficulty of breaking up. Power values based upon the law of variation established in the actual diagram have been assumed and corresponding lines drawn for four other feeds (the dotted lines), which indicates what may be expected with feeds of 1-64, 2-64, 7-64 and 8-64-in., respectively, under similar conditions.

These tests were not carried out as far as was desired, but the results are useful in that they indicate what may be expected within certain limits during a machining operation under certain definite conditions. It will indicate lines along which further investigations of this nature may be carried to very good advantage, not only for the designers, but also for the users of machine tools.

We are indebted for this information to Mr. J. C. Steen, of the Cincinnati Shaper Company, by whom these tests were made.

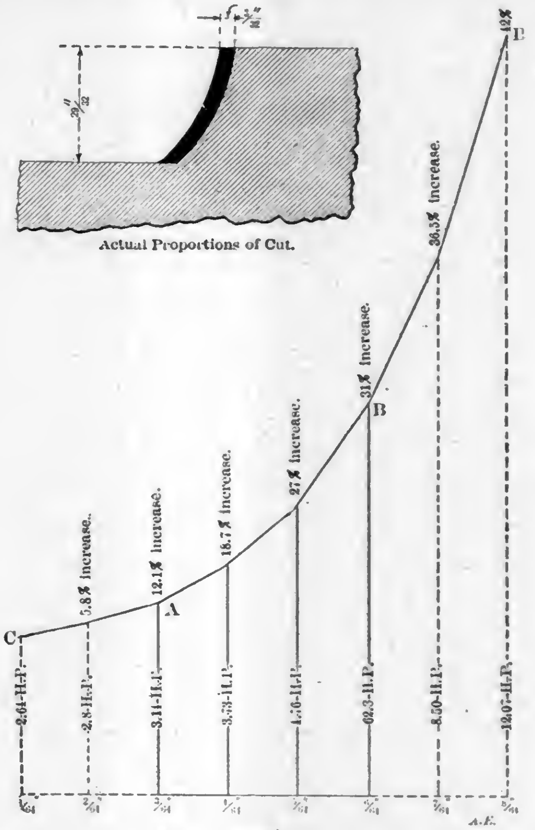


DIAGRAM OF POWER REQUIRED WITH VARYING CUTS.

NEW PASSENGER LOCOMOTIVE.

PENNSYLVANIA LINES WEST OF PITTSBURG.

4-4-2 TYPE.

CLASS E 2 A (PENNSYLVANIA CLASSIFICATION).

In general appearance this locomotive resembles the Class E 2 (AMERICAN ENGINEER, June, 1902, page 188), except that the steam dome and sand box are separate. Many of the details of construction are changed, and the engravings are selected with a view of illustrating these. By comparing the lists of dimensions the boilers are seen to be almost identical in capacity and construction. Ten locomotives have piston valves with inside admission and direct valve motion, while twenty-two have Richardson valves. The engravings show the construction of both.

The frames are specially interesting, in that they are widened at the jaws in order to secure lateral strength. This feature is clearly shown in the engravings. In front of the splices the frames are 4 x 8 in. in section, and at the cylinders 4½ x 7 in. At the driving wheels the section is 5½ x 3 in. Frequent cross braces stiffen the frames laterally. These are shown in the side elevation. At the front ends of the frames are large cast steel gusset braces. The engravings are worthy of careful study which will reveal many interesting features, such as the ample steam passages in the cylinder saddles, which space limits do not permit of discussion in detail.

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	Locomotives. Penna.	M. C.
Weight in working order	176,600 lbs.	176,000 lbs.
Weight on drivers	109,000 lbs.	95 000 lbs.
Weight of engine and tender	311,100 lbs.	286,500 lbs.
Maximum tractive power	23,755 lbs.	24,700 lbs.
$\frac{\text{Adhesive weight}}{\text{Tractive effort}}$ =	4.56	4.29
Heating surface	2,639 sq. ft.	3,521 sq. ft.
Grate area	55.5 sq. ft.	50.3 sq. ft.

PASSENGER LOCOMOTIVE, 4—4—2 TYPE.—PENNSYLVANIA LINES.

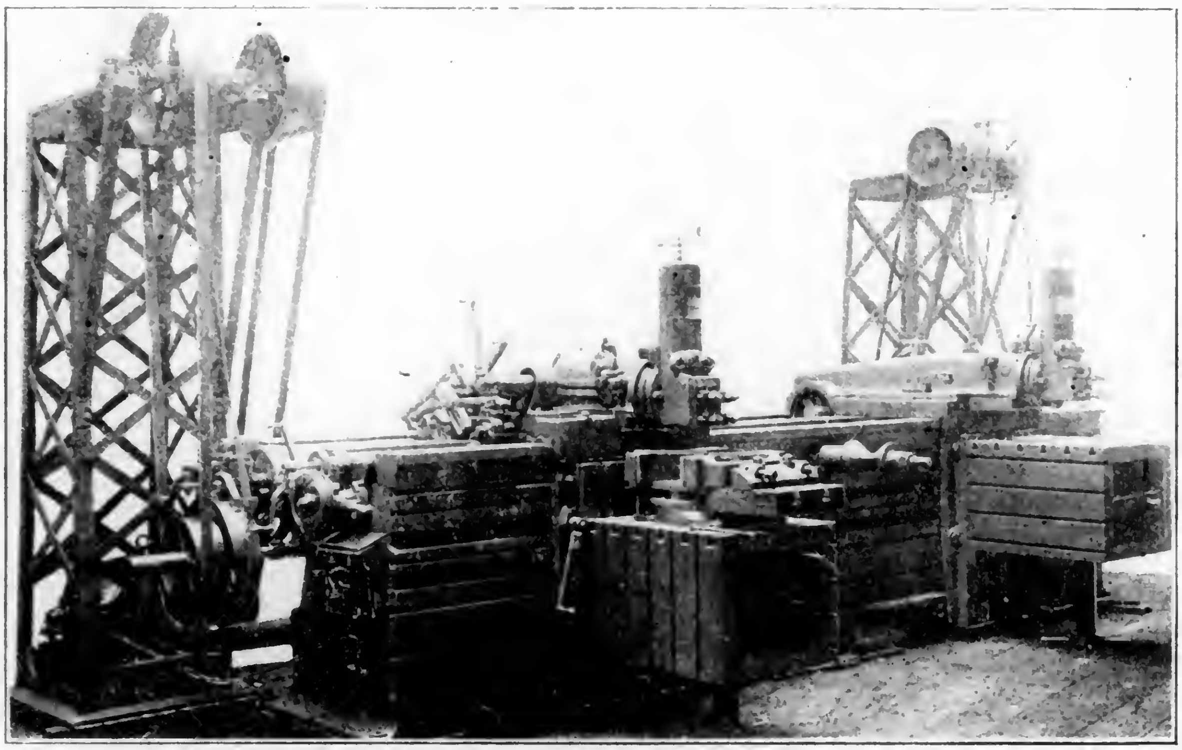
PENNSYLVANIA CLASS E 2 a.

POWER TEST OF AN ELECTRICALLY-DRIVEN SHAPER.

CINCINNATI SHAPER COMPANY.

A very important advantage is gained from the individual-drive method of electrically operating machine tools by reason of the facility offered for easily and accurately measuring, electrically, the power required for various machining operations. The expenditures of power required for all variations in cuts and feeds may be readily determined as voltmeter, and ammeter readings can be taken of the current demanded by the motor while the cut is under way.

An interesting power test was recently made in this way by the Cincinnati Shaper Company, Cincinnati, Ohio, upon a large double-head motor-driven traverse shaper, which had been arranged especially for motor driving by the application of an independent motor for the drive of each head. The accompanying engraving presents a general view of this tool thus equipped, the motors used for the two drives being each of the constant-speed type. Both motors were of 5-h.p. capacity, made by Jantz & Leist, of Cincinnati, and arranged to operate upon a 500-volt, direct-current circuit. They are each mounted upon an independent base at the end of the machine, which carries a strong, lattice-braced steel superstructure for the support of the countershaft.



36-INCH DOUBLE-HEAD MOTOR-DRIVEN TRAVERSE SHAPER. CINCINNATI SHAPER CO.

USED IN THE POWER TEST WITH VARIOUS FEEDS.

Each motor is belted direct to its countershaft through a pair of four-step cone pulleys, from which countershaft are run the two belts necessary for the slow forward and the quick return motions for the ram. The control of each motor is through a knife switch and a starting rheostat, located upon the end of the shaper's bed and protected from metal chips and dirt by hood

This shaper is of a new design, each ram of the tool having a stroke of 36 ins. and independently driven through steel gearing and racks of extra strength. A notable feature is the double-gibbed arrangement of staying the ram saddles to the bed, in order to properly resist the stress due to the very heavy cuts resulting from the use of the new high duty tool steels; besides the usual gibbing of the saddle to the front side of the bed there is also a taper gib underneath the saddle bearing against the front edge of the back member of the bed, thus dividing the thrust between the two top members of the bed instead of concentrating it at the front edge.

The object of the test was to determine by the above mentioned electrical method the actual amount of power required for driving the machine during a machining operation in which the feeding ratio only was varied regularly. The work machined during the test was a piece of cast iron of close grain, but of medium hardness. A uniform depth of cut was used throughout, the feed being varied by 1-16 in. in the different tests.

The motor operated at a speed of 1,050 revolutions per minute, while the ram was geared to travel at a rate of 20 ft. per minute on the forward stroke and of 65 ft. per minute on the return stroke. Voltmeter and ammeter readings were taken while the tool was cutting, fifteen or twenty readings being taken for each rate of feed, and from these results averages were calculated, which were considered to represent very closely the result of the uniform conditions for each rate. This was particularly necessary because the voltage of the motor supply current varied from 480 to 550. From these average values of the voltage and current, the power used by the motor was calculated in horse-power, as indicated in the following table:

POWER REQUIRED AT THE MOTOR.

Motor, running light, driving countershaft and pulleys on machine, only	1.66-H.P.
Gross power required to drive the machine running light, during forward motion of ram	2.38-H.P.
Net useless power absorbed by forward motion of ram at approximately 20 ft per minute	.72-H.P.
Gross power required to drive the machine running light, at instant of reverse of ram	7.71-H.P.
Net useless power absorbed during reverse motion of ram at approximately 65-ft per minute	6.05-H.P

Power required at the motor with the tool cutting at the constant depth of 29-32-in., but with varying feeds:

For a feed of 3-64-in.—gross	5.52-H.P.
For a feed of 3-64-in.—net	3.14-H.P
For a feed of 4-64-in.—gross	6.11-H.P.
For a feed of 4-64-in.—net	3.73-H.P.
For a feed of 5-64-in.—gross	7.14-H.P.
For a feed of 5-64-in.—net	4.76-H.P.
For a feed of 6-64-in.—gross	8.61-H.P.
For a feed of 6-64-in.—net	6.23-H.P.

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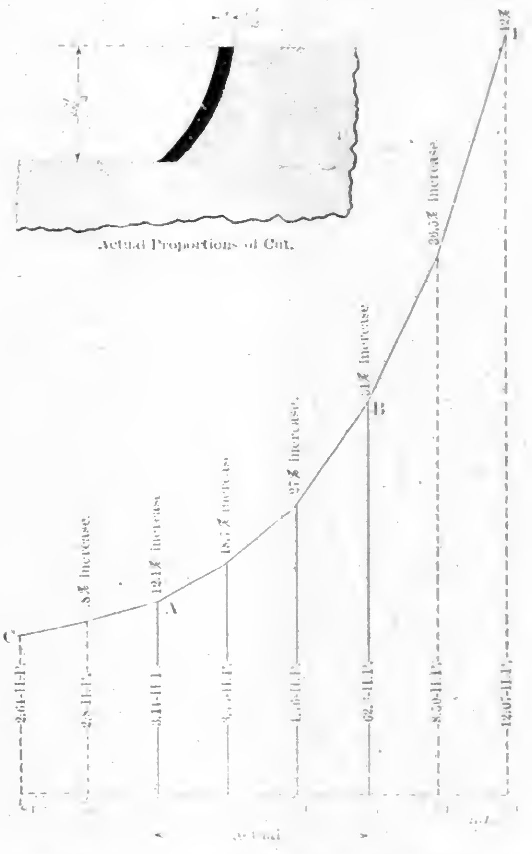

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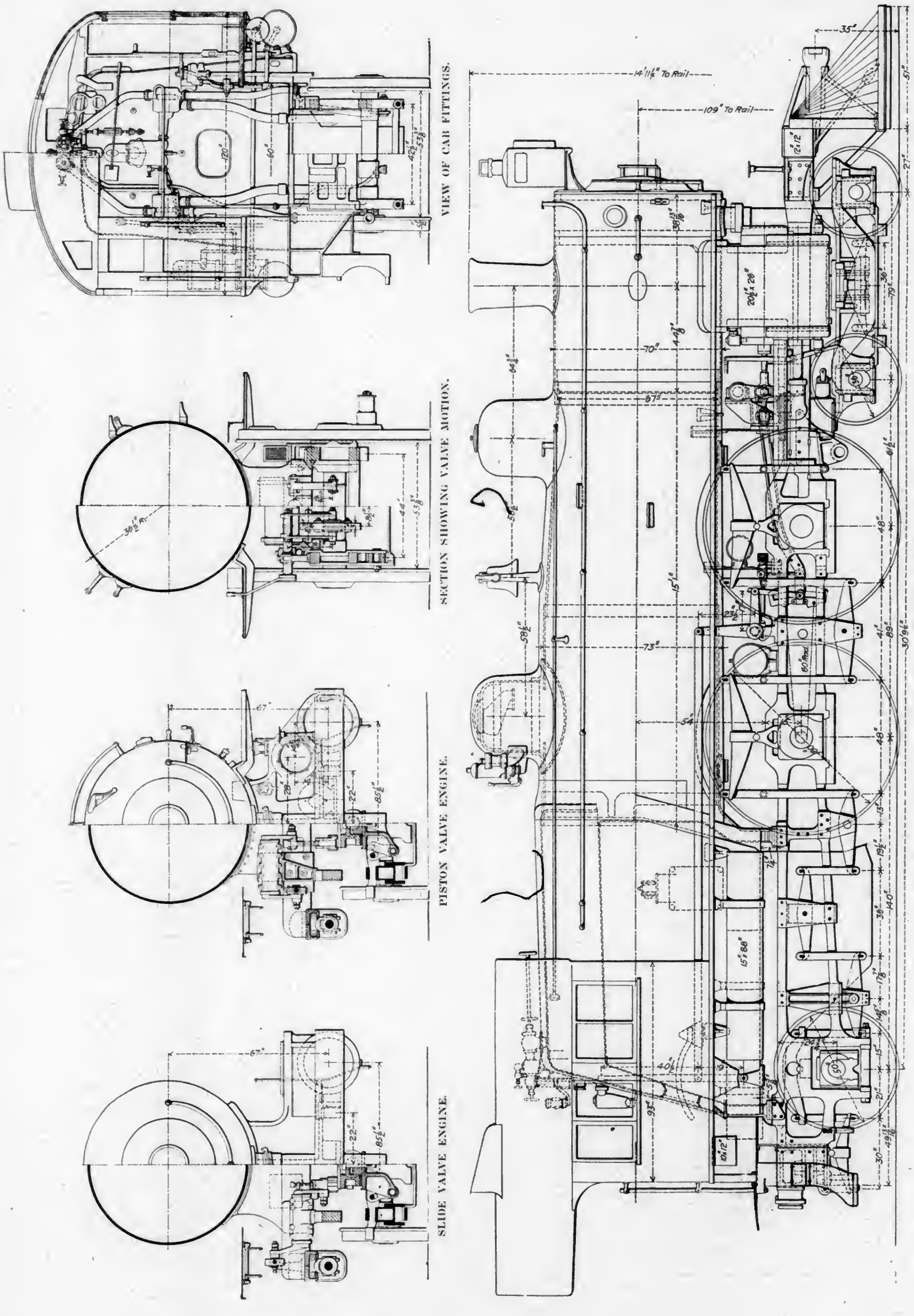
$\frac{\text{Adhesive weight}}{\text{Tractive effort}}$	4.56	4.29
Heating surface	2,639 sq. ft.	3,521 sq. ft.
Grate area	55.5 sq. ft.	50.3 sq. ft.

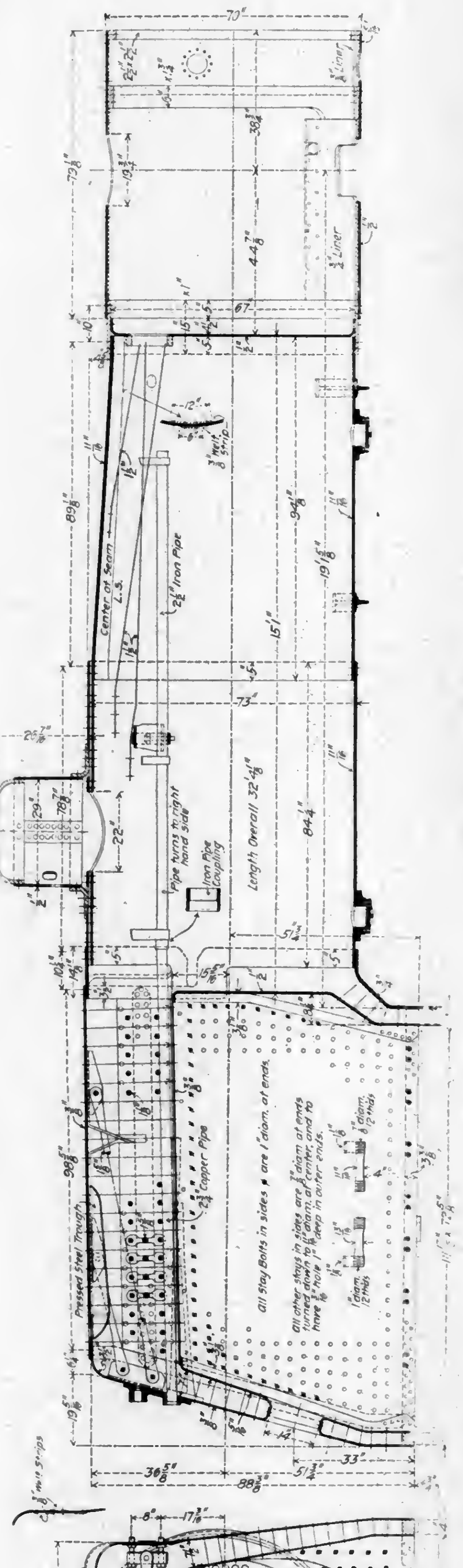
PASSENGER LOCOMOTIVE, 4—4—2 TYPE.—PENNSYLVANIA LINES.

PENNSYLVANIA CLASS E 2 a.

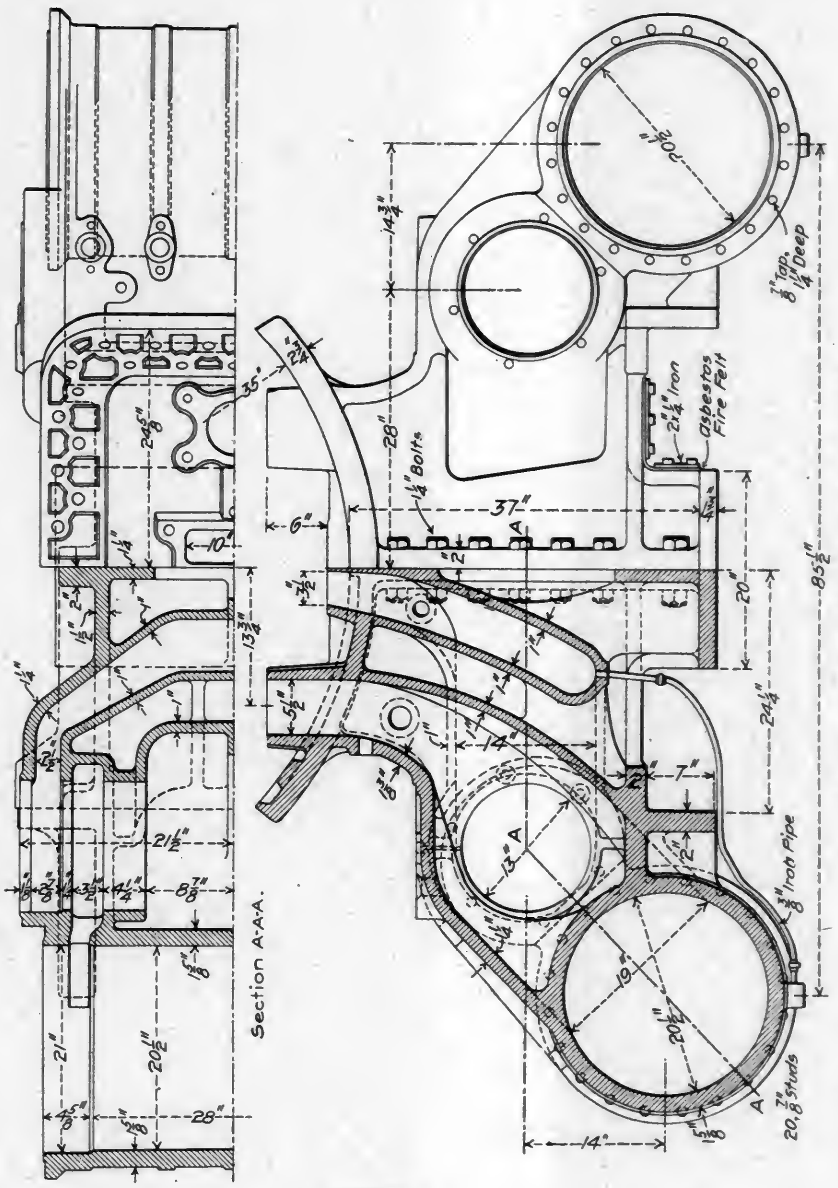


PASSENGER LOCOMOTIVE, 4—4—2 TYPE—PENNSYLVANIA LINES.

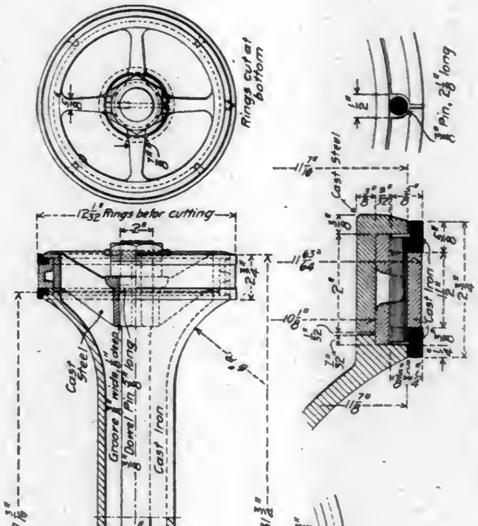
BUILT BY THE AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS.



SECTIONS OF BOILER.



SHOWING CYLINDERS FOR PISTON VALVES.



PISTON VALVE.

PASSENGER LOCOMOTIVE, 4—4—2 TYPE—PENNSYLVANIA LINES.

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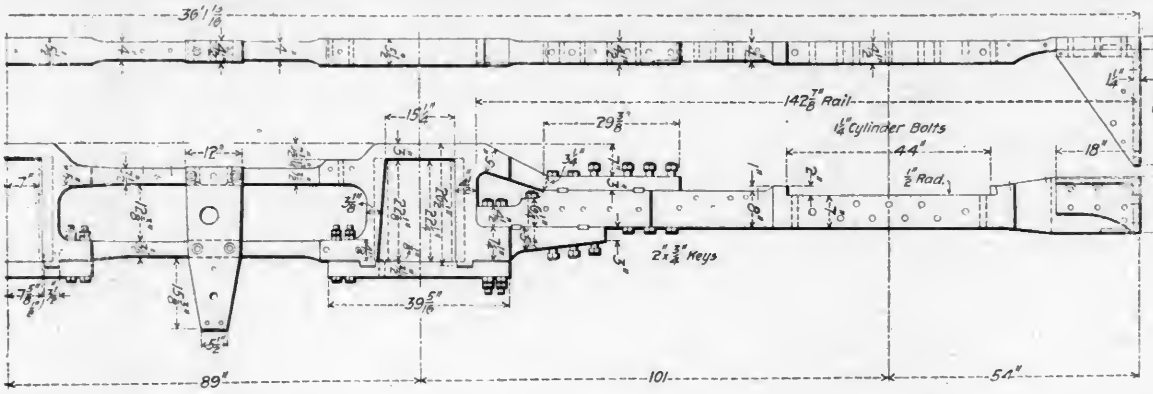


While necessarily based in both cases upon assumption, the following is interesting as showing the comparison between the work which could be done by the heating surface of the Pennsylvania engine, providing it could haul the Michigan Central train at the speed stated. Based upon a train resistance of 16 lbs. per ton and 10 per cent. internal friction of the engine, the horse power required is 1,915, and the tractive effort to produce this would be 12,689 lbs. This would call for a mean effective pressure of 94 lbs. and an evaporation of 49,790 lbs. of water per hour. At a ratio of 7 lbs. of water per pound of coal, the coal consumption would be 7,113 lbs. per hour. This would mean 128 lbs. of coal per square foot of grate per hour, 18.8 lbs. of water per square foot of heating surface per hour, and 1.38 sq. ft. of heating surface per horse power per hour. The Michigan Central locomotive gives a figure of 1.83 sq. ft. of heating surface per horse power hour.

If these assumptions are fair, and they appear to be, the Pennsylvania locomotive is capable of a remarkable performance with a small heating surface. Evidently a great deal remains to be learned about locomotive boiler proportions. The present enormous heating surfaces may prove to be obtained somewhat at the expense of circulation.

RATIOS.

Tractive power used below	23,750 lbs.
Total cylinder volume	9.94 cu. ft.
Heating surface to cylinder volume	265.5
Tractive weight to heating surface	41.3
Tractive weight to tractive effort	4.59
Tractive effort to heating surface	8.99
Heating surface to grate area	47.54
Tractive effort × diameter of drivers ÷ heating surface	719.20
Heating surface to tractive effort	11.1%
Total weight to heating surface	66.9

E—2—a PASSENGER LOCOMOTIVE.
Pennsylvania Lines West of Pittsburg.
General Dimensions.

Gauge	4 ft. 9 ins.
Fuel	Bituminous coal
Weight in working order	176,600 lbs.
Weight on drivers	109,000 lbs.
Weight engine and tender in working order	311,100 lbs.
Wheel base, driving	7 ft. 5 ins.
Wheel base, rigid	7 ft. 5 ins.
Wheel base, total	30 ft. 9½ ins.
Wheel base, total, engine and tender	60 ft. 2 9-16 ins.

Cylinders

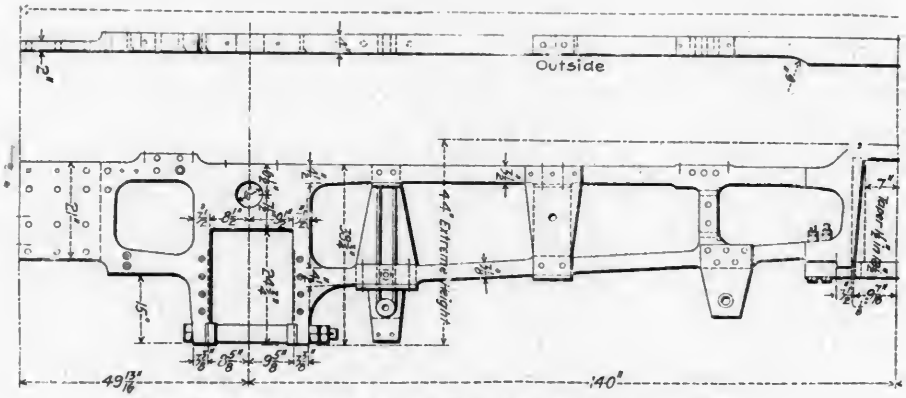
Diameter of cylinders	20½ ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5 ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast iron
Kind of piston-rod packing	Pennsylvania Railroad standard
Size of steam ports (For last 22 engines)	20 ins. x 1½ ins.
Size of exhaust ports (For last 22 engines)	20 ins. x 3 ins.
Size of bridges (For last 22 engines)	1¼ ins.

Valves.

Kind of slide valves:	First 10 engines, piston valve; last 22 engines, Richardson
Greatest travel of slide valves	7 ins.
Outside lap of slide valves	1¾ ins.
Inside clearance of slide valves	3-32 ins.
Lead of valves in full gear	1-32 in. lead in full gear F. & B.
Kind of valve-stem packing	Pennsylvania Railroad standard

Wheels, Etc.

Number of driving wheels	**4**
Diameter of driving wheels outside of tire	**80 ins.**
Material of driving wheel centers	Cast steel
Thickness of tire	4 ins.
Tire held by	Shrinkage and Gibson fastening
Driving box material	Cast steel
Diameter and length of driving journals	9½ ins. diameter x 13 ins.
Diameter and length of main crankpin journals:	Main side, 7¾, x 5 ins.; 6 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals,	5½ ins. diameter x 4½ ins.
Engine truck, kind,	Four-wheel swivel cen. Pennsylvania Railroad standard
Engine truck, journals	5½ ins. diameter x 10 ins.
Diameter of engine truck wheels	36 ins.



FRAMES OF PASSENGER LOCOMOTIVE, PENNSYLVANIA LINES.

Boiler.

Style	Belpaire
Outside diameter of first ring	67 ins.
Working pressure	205 lbs.
Thickness of plates in barrel and outside of firebox:	1 in., 11-16 in., ½ in., ⅜ in., ¾ in., 13-16 in.
Firebox, length	111 ins.
Firebox, width	72 ins.
Firebox, depth	Front, 67 1-16 ins.; back, 64 7-16 ins.
Firebox plates, thickness:	Sides, 5-16 in.; back, 5-16 in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	4 ins. front, 4 ins. sides, 3½ ins. back
Tubes, material and gauge	Iron; 11 B. W. G.
Tubes, number	315
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft. 1 in.
Heating surface, tubes	2,474 sq. ft.
Heating surface, firebox	165.7 sq. ft.
Heating surface, total	2,639.7 sq. ft.
Grate surface	55.5 sq. ft.
Exhaust pipes	Single; low
Exhaust nozzles	5-in., 5¼-in., 5½-in.
Smokestack, inside diameter	16 ins. and 18¾ ins.
Smokestack, top above rail	14 ft. 11½ ins.

Tender.

Style	Water bottom
Weight, empty	56,150 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	20 ft. 6 ins.
Tender frame	10-in. steel channels
Tender trucks:	Two 4-wheel, center bearing, Pennsylvania Railroad standard
Water capacity	7,000 U. S. gals.
Coal capacity	10 tons

Mr. Leigh Best, secretary of the American Locomotive Company, sends us a copy of the locomotive catalogue which has just been prepared for distribution in foreign countries. It comes just as we go to press, which precludes an extended notice. The printing, etc., embossed cover and the engravings surpass in excellence every publication of this kind which has come to our notice. It presents a record of noteworthy locomotives now running in this country, together with a large number built for foreign roads, giving the data in both French and English.

IMPROVED TREATMENT OF CAST IRON CAR WHEELS.

BY F. E. SEELEY.

With the introduction of 100,000 lbs. capacity cars and the resulting increased stresses in the cast-iron car wheel, the question naturally arises as to whether that wheel has reached its limit of strength. Many believe this to be the case and advance in support of their belief the increased failures of cast-iron wheels in the proportion of 3 to 1 when applied to 100,000 lbs. capacity cars over those of 60,000 lbs. capacity. Manufacturers, on the other hand, claim that the limit of strength has not been reached, but that the limit in the price paid for cast-iron wheels necessarily limits the quality of pig-iron used and the attention and supervision necessary for the most improved manufacture of the wheels.

The New York Railway Club made this the subject of their discussion in January, and too much cannot be said of the advantages of these discussions or the good resulting from them.

The writer some time ago was invited to investigate an improved treatment of cast-iron wheels which is well worth consideration. First, however, a brief summary of what a cast-iron car wheel of to-day is called upon to stand, compared to one of two or three years ago, is in order.

A wheel of to-day, weighing 25 per cent. more than formerly, with the same section of flange, is forced to carry 75 per cent. more load at 100 per cent. greater speed and be subject to injurious effects at least three times those which it was formerly subject to, and the strains and heat due to brake application. It must be guaranteed for 50 per cent. greater life and subject to severe test and the option of the railroad —all for the same price.

A study of the stresses in a cast-iron wheel is not complete without knowledge of the brake shoe in its relation to and effect on the wheel. The brake shoe has little effect upon the hard chill of the wheel tread so far as actually wearing into or cutting the wheel is concerned. Indirectly, however, its effects are enormous and are often responsible for the failure of the wheel. The brake shoe is the agent by which all the energy stored in the wheel due to rotation and load is converted into heat, and the rise in temperature of the wheel depends upon the amount of work done by the shoe upon the wheel and the time in which the work is done. The chilled iron does not absorb or conduct heat readily and internal strains are introduced and create a tendency for the wheel to crack. That this is a fact is proved by an examination of wheels removed from 100,000 lbs. capacity cars. These showed fine checks or cracks in the tread and flange which seemed to develop in the dividing line between the gray and white iron and then work through to the surface.

Chilled white iron, while excessively hard, is very brittle and crystalline. The only way manufacturers have of toughening the chill is to place the wheels in a pit after they are cast, cover them over and allow them to gradually cool for three or four days. This tends not only to relieve internal strains, but also to diminish the brittleness of the chilled portion of the wheels, increasing thereby its ability to withstand shocks, while the hardness is effected to only a very slight extent. This is common practice among all makers and equally available to all, consequently any superiority of a wheel of one make over that of another lies in the use of superior pig-iron, superior casting methods or both. If, therefore, a method of treating a wheel exists that will further improve it after it is cast, then a superior wheel to any now cast can be made; and if this treatment can be applied at slight expense it seems in the line of wisdom and economy to give it a trial.

The process of treatment is patented by the Standard Steel Car Wheel Company, of Springfield, Mass., and is briefly as follows: After the wheels are once cast and allowed to cool according to the usual method, they are placed in a specially constructed hydro-carbon furnace and heated. After being subjected to a certain heat for a few hours they are allowed to gradually cool for perhaps two days. This process, simple in itself, tends to relieve all internal stresses and changes the chill from a very hard and very brittle composition to a very hard and exceedingly tough composition, as well as toughening the wheel throughout. The writer's understanding of the chemical changes undergone is as follows: Carbon exists in cast iron in two states—graphitic and combined. When a wheel chills, a portion of the graphite carbon changes to a combined form, alloying with the iron as seen in the chill. When this is further heated a portion of the combined carbon undergoes a further change to what is commonly known as temper carbon, which is exceedingly tough.

The life of a cast-iron wheel depends upon the ability of the chilled portion to withstand shock, wear and the strains due to heating by brake shoes. If this process, as is claimed for it, will toughen the tread and flanges, and by relieving internal stresses decrease those due to heating, it is well worth general adoption. It is not only the actual strength of the metal that is desired, but a toughness as well—what in a test piece with a load applied at the center would be a combination of strength and toughness, or resilience, which is the resisting force of the material. Comparative tests of bars show that those treated by this method require nearly twice the load to break them, a considerably greater deflection, and a resilience over two and one-half times that attained in those cast in the usual manner and not treated. Tests of trolley and freight wheels showed that wheels treated after this manner would withstand in most cases double the number of blows to those similarly cast but not so treated.

Considering the cheapness and simplicity of this treatment and the increased strength and durability possible when so treated, along with the recent failures of cast-iron wheels under cars of 40 and 50 tons capacity, the introduction of this method seems worthy of serious consideration.

"ANTI-FRICTION" CAR SIDE BEARINGS AND CENTER PLATES.

EFFECT ON TRAIN RESISTANCE.

PITTSBURG & LAKE ERIE.

This road has for five years been experimenting, systematically, with ball bearing center plates and side bearings. Mr. L. H. Turner, superintendent of motive power, now considers the matter to have gone beyond the experimental stage and he is sure that "it is simply impossible to have sharp flanges under cars equipped with these appliances." With the entire elimination of flange wear and rail wear from the flanges, he has found a marked reduction of train resistance. Some of the results of his tests were recorded in this journal in February, 1902, page 45. Mr. Turner has carried his experiments further and found that these bearings produce a marked effect upon the tonnage rating of locomotives. He has supplied the following results:

THE PITTSBURG & LAKE ERIE RAILROAD.

Report of train test between Fleming Park and College:

Test Train No. 1.—All freight cars equipped with Hartman ball-bearing center plates and side bearings.

	Tons.
48 steel gondolas	3,010
1 dynamometer car	16.5
1 private car	51
1 caboose	10
	3,087.5

Test Train No. 2.—All freight cars equipped with plain center plates and side bearings.

	Tons.
48 wooden and steel coal cars	2,522.5
1 dynamometer car	16.5
1 private car	51
1 caboose	10
	2,600.0

Distance between Fleming Park and College	26 miles
Average drawbar pull, entire distance, test No. 1	14,470 lbs.
Average drawbar pull, entire distance, test No. 2	12,780 lbs.
Reduction of drawbar pull for test No. 1, below that expected under conditions of No. 2, per cent	4.9
Average resistance in pounds per ton, test No. 1	4.68
Average resistance in pounds per ton, test No. 2	4.91
Percentage of resistance in favor of test No. 1	4.9
Average miles made per hour, test No. 2	14.72
Percentage in favor of test No. 1	11.4
Required to start truck with	75 lbs. 9%

While the average results are very favorable to the ball-bearing, a still better showing would have been made had the condition of the rail been the same during both tests. A light rain during most of the time that Test No. 1 was being made required a liberal use of sand, which of necessity increased the train resistance. In arriving at results of these tests where the conditions are so varying, it is wise to consider only average results, or those that manifest themselves in the earning value of the train. We find that train No. 1, witn ball-bearing center plates and side oearings, notwithstanding the handicap due to the use of sand, made 11.4 per cent. greater speed, with 5.5 per cent. less drawbar pull. The revenue tonnage approximated 66 per cent. of the total weight of train; the increased earnings due to reduced train resistance at six mills per ton mile amounts to $59.60 for each 100 train miles. In addition to the increased earnings, the ease with which trucks adjust themselves when equipped with ball-bearing appliances entirely eliminates sharp wheel flanges and side rail wear, which is of great importance in safe and economical railroad operation.

Another and equally interesting test was made in August, 1900, with a car that had been equipped with Hartman ball-bearings for over three years. Great pains were taken to get as nearly accurate results as possible in this test, and in order to do so a turn-table 7 ft. in length was constructed, and each truck of the car handled separately. A dynamometer was used to measure the power required to displace each truck. The following report gives results of the four tests made:—

CURVE RESISTANCE ON CARS EQUIPPED WITH HARTMAN BALL BEARING CENTER PLATES AND SIDE BEARINGS, IN COMPARISON WITH THE ORDINARY FLAT CENTER PLATES AND SIDE BEARINGS.

FIRST TEST.

Flat center plate and side bearing with 1/8 in. deflection of body bolster resting on side bearing.

	Resistance.	
Required to start truck	800 lbs.	100%
Required to displace truck 2 ins	1,100 lbs.	100%

SECOND TEST.

Flat center plate without side bearing.

	Resistance.	
Required to start truck	275 lbs	34%
Required to displace truck 2 ins	525 lbs	48%

THIRD TEST.

Hartman ball-bearing center plate and side bearing with 1/8-in. deflection of body bolster resting on side bearing.

	Resistance.	
Required to start truck	75 lbs	9%
Required to displace truck 2 ins	450 lbs	40%

FOURTH TEST.

Hartman ball-bearing center plate without side bearing.

	Resistance.	
Required to start truck	75 lbs	9%
Required to displace truck 2 ins	325 lbs	29%

Displacement of the truck of 2 ins. corresponds to a 154-degree curve. The tests were made with P. McK. & Y., car No. 12,162, loaded, total weight 91,000 lbs., equally distributed. More power was required to displace the truck 2 ins. than it did to start it, because of the construction of the groove in the plate. The grooves are deepest in the center. When cars take heavy curves the body of the car is raised slightly by the rotating movement of the balls. All results of the test prove conclusively that a large amount of center plate resistance can be removed by the use of proper appliances.

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

One thing specially needed in our railroad organizations is a system of promotion of subordinates which will render it possible to replace a man high in authority without jeopardizing the position of anyone, even down to the office boy. It is, and always will be, expensive to operate a large enterprise when the subordinate officials are always anxious as to their tenure because the presiding official is one who owes his appointment to supposed ability to "make a record" in a short time. The only records worth making are not made in a short time, and the conditions of society to-day are such as to render it advisable to inaugurate policies of management upon a long-term basis. Progress is too rapid to make this easy, but it is none the less necessary. Railroads with traditions are rare. It is apparent that those having them are not greatly troubled with labor disturbances, and where "tradition" stands for a definite policy, well founded and consistently developed, it is an excellent thing. It may be carried so far as to interfere with progress, but that is not commendable and is not the kind under discussion. What is wanted is a feeling among subordinates which makes them personally interested in the success of their superior. This is occasionally found, but not often enougn. It involves a principle which should be cultivated, because it pays. This is not a question of sentiment. It is a business principle

In visiting the heads of motive power departments to-day we find a marked change in the subjects which are uppermost in their minds. A few years ago the subjects discussed were not as important as are those of the present time. It is becoming evident that it is no longer sufficient for a superintendent to be a good mechanic. He must be an executive, an organizer and a business man. The present problems are business problems and they are growing more important every day. We are evidently at the beginning of a new era with respect to the mechanical departments of railroads, and it may be called the era of the application of commercial principles; those principles which have led American industrial enterprises to their high degree of success. This means much to the railroads and it opens great opportunities for young men who are preparing to fill the important positions of the future.

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MOTOR-DRIVEN MACHINE TOOLS.

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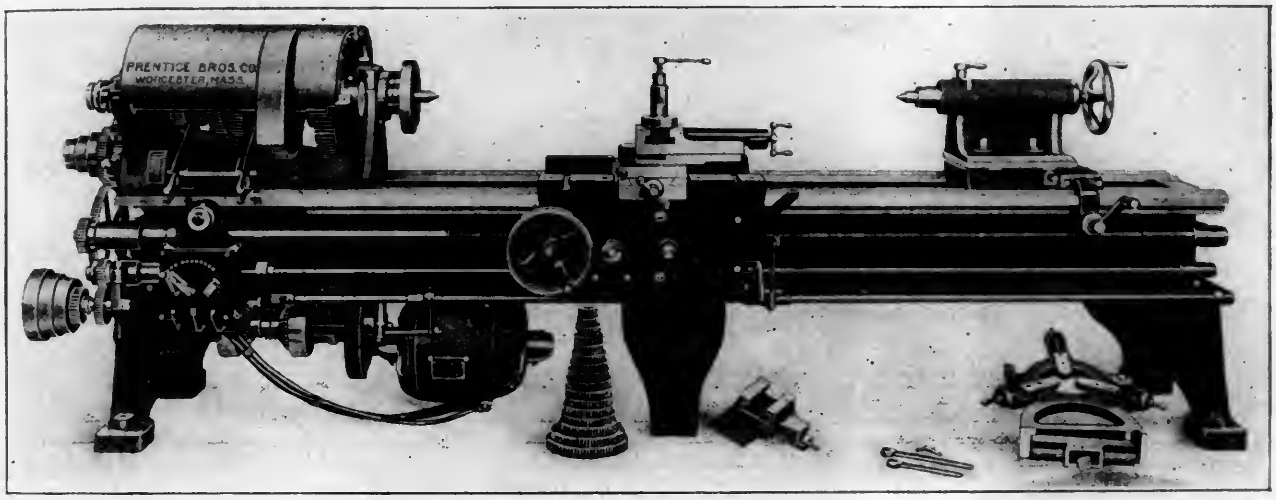
The principle of individually driving machine tools by electric motors has successfully passed the experimental and probationary states and has come to be regarded as a necessary feature of the equipment of every modern machine shop. One of the very important details of the application of this type of drive has, however, remained in an unsettled condition owing to the diversity of practice in the type of motor used for the drive. If alternating current motors be used all variations of speed must be obtained outside of the motor, as is also the case with the constant-speed type of direct current motors which are frequently used, and this requires additional mechanical complications to which most machine tools are not adapted. If variable-speed motors be used, of which there are several different types, the problem is greatly simplified, but even in that case the best method of incorporating the motor's support into the design of the machine seems to be unsettled.

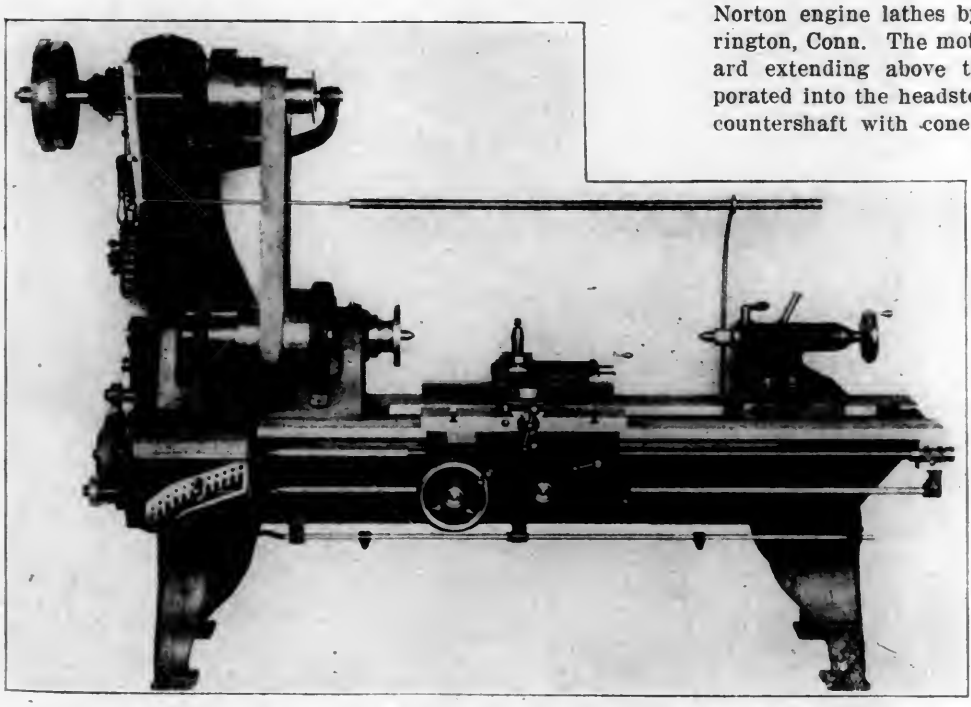
The accompanying engravings present illustrations of several individually-driven lathes which will indicate the trend of the best practice amongst the tool makers, both as to the application of constant-speed and of variable-speed motors. As will be noted, several radical improvements have been introduced, which are of unquestionable value. Much data has been obtained regarding this valuable subject in the past few years, which will tend to exert an important influence upon future work in this direction; one of the most important decisions that has been generally arrived at by the users of machine tools is that of strictly avoiding the use of motors which are not of standard and interchangeable designs, so as to be readily replaced in case of accident or repairing.

Below is presented an engraving which will show the type of motor-drive adopted for individual drives upon the Hendey-



CONSTANT-SPEED GEARED DRIVE ON A 26-IN. PRENTICE LATHE.—PRENTICE BROS. COMPANY.

Norton engine lathes by the Hendey Machine Company, Torrington, Conn. The motor is mounted upon the top of a standard extending above the lathe, rather than being incorporated into the headstock; this method requires the use of a countershaft with cone pulleys in order to afford the speed changes at the spindle necessary for general work.



CONSTANT-SPEED BELTED DRIVE FOR THE HENDEY-NORTON LATHE, USING CONE PULLEYS.—HENDEY MACHINE COMPANY.

The motor used is of the constant-speed, back-geared type, with a double gear and clutch arrangement between the motor and back gear shafts by which two different speeds may be delivered from the cone pulley. The standard carrying the motor is bolted rigidly to the lathe bed, and is strongly webbed to prevent disturbing vibrations. The motor is attached to a hinged plate on top of the standard, at the front end of which plate there is a short-throw cam to allow the plate a slight drop for loosening the belt when it is desired to shift from one step of the cone to another. The cam is supported by adjustable posts which permit of taking up any stretch occurring in the belt.

The motor is controlled by a knife switch and starting rheostat on the left side of the motor standard, the motion of the spindle being controlled by the rod extending above the bed, which throws the clutch on the back-gear shaft free for stopping, or into connection with either gear for running. Owing to the reversing device at the apron for the carriage, the Hendey Company do not recommend a reversing motor with its attendant extra expense and complication. The sizes of motors recommended for the different sizes of lathes are as follows: 12 to 14 in. swing, one horse power; 16 to 24 in. swing, two horse power; 32 in. swing, three horse power.

At the top of this page is shown the 26-in. motor-driven lathe which has been developed by Prentice Brothers Company, Worcester, Mass. The type of drive here advocated is that of

Distance between Fleming Park and College	26 miles
Average drawbar pull, entire distance, test No. 1	11,170 lbs.
Average drawbar pull, entire distance, test No. 2	12,780 lbs.
Reduction of drawbar pull for test No. 1, below that expected under conditions of No. 2, per cent.	4.9
Average resistance in pounds per ton, test No. 1	4.68
Average resistance in pounds per ton, test No. 2	4.91
Percentage of resistance in favor of test No. 1	4.9
Average miles made per hour, test No. 2	11.72
Percentage in favor of test No. 1	11.1
Required to start truck with	75 lbs. 9%

While the average results are very favorable to the ball-bearing, a still better showing would nave been made had the condition of the rail been the same during both tests. A light rain during most of the time that Test No. 1 was being made required a liberal use of sand, which of necessity increased the train resistance. In arriving at results of these tests where the conditions are so varying, it is wise to consider only average results, or those that manifest themselves in the earning value of the train. We find that train No. 1, with ball-bearing center plates and side bearings, notwithstanding the handicap due to the use of sand, made 11.1 per cent. greater speed, with 5.5 per cent. less drawbar pull. The revenue tonnage approximated 66 per cent of the total weight of train; the increased earnings due to reduced train resistance at six mills per ton mile amounts to $59.60 for each 100 train miles. In addition to the increased earnings, the ease with which trucks adjust themselves when equipped with ball-bearing appliances entirely eliminates sharp wheel flanges and side rail wear, which is of great importance in safe and economical railroad operation.

Another and equally interesting test was made in August, 1900, with a car that had been equipped with Hartman ball-bearings for over three years. Great pains were taken to get as nearly accurate results as possible in this test, and in order to do so a turn-table 7 ft. in length was constructed, and each truck of the car handled separately. A dynamometer was used to measure the power required to displace each truck. The following report gives results of the four tests made:—

CURVE RESISTANCE ON CARS EQUIPPED WITH HARTMAN BALL BEARING CENTER PLATES AND SIDE BEARINGS, IN COMPARISON WITH THE ORDINARY FLAT CENTER PLATES AND SIDE BEARINGS.

FIRST TEST.

Flat center plate and side bearing with ½ in. deflection of body bolster resting on side bearing

	Resistance.	
Required to start truck	800 lbs.	100%
Required to displace truck 2 in.	1,100 lbs.	100%

SECOND TEST.

Flat center plate without side bearing.

	Resistance	
Required to start truck	275 lbs.	34%
Required to displace truck 2 ins.	525 lbs.	48%

THIRD TEST.

Hartman ball-bearing center plate and side bearing with ½-in. deflection of body bolster resting on side bearing.

	Resistance.	
Required to start truck	75 lbs.	9%
Required to displace truck 2 ins.	450 lbs.	40%

FOURTH TEST.

Hartman ball-bearing center plate without side bearing.

	Resistance	
Required to start truck	75 lbs.	9%
Required to displace truck 2 ins.	325 lbs.	29%

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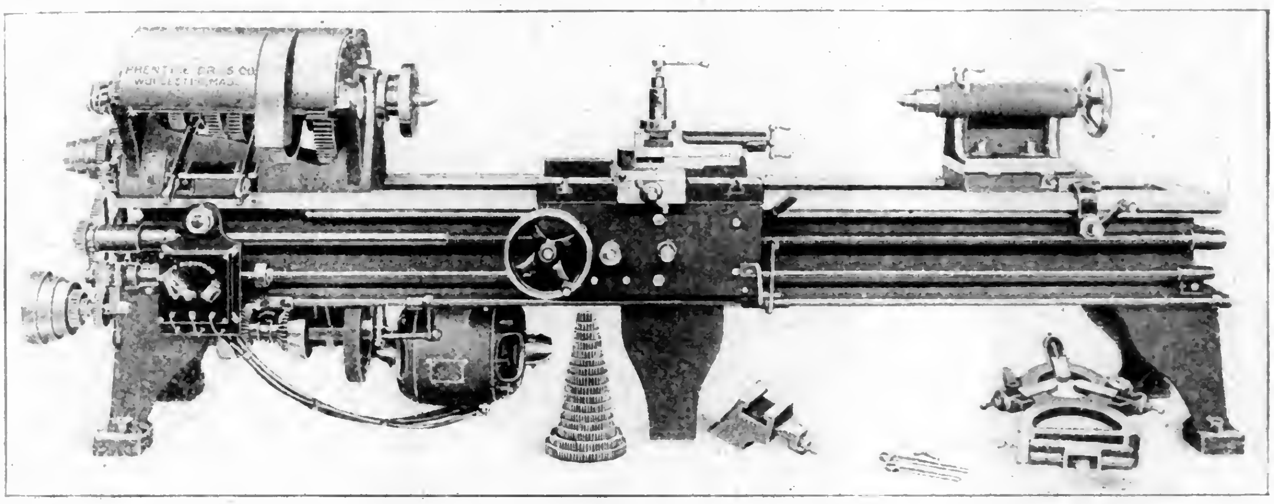
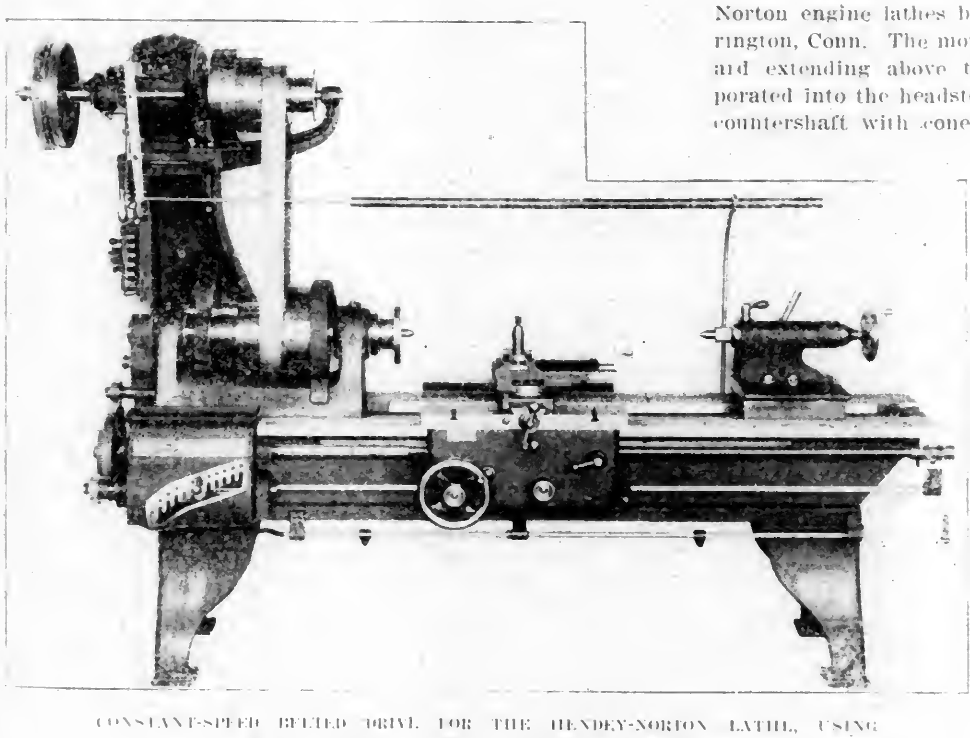


CONSTANT-SPEED GEARED DRIVE ON A 26-IN. PRENTICE LATHE.—PRENTICE BROS. COMPANY.



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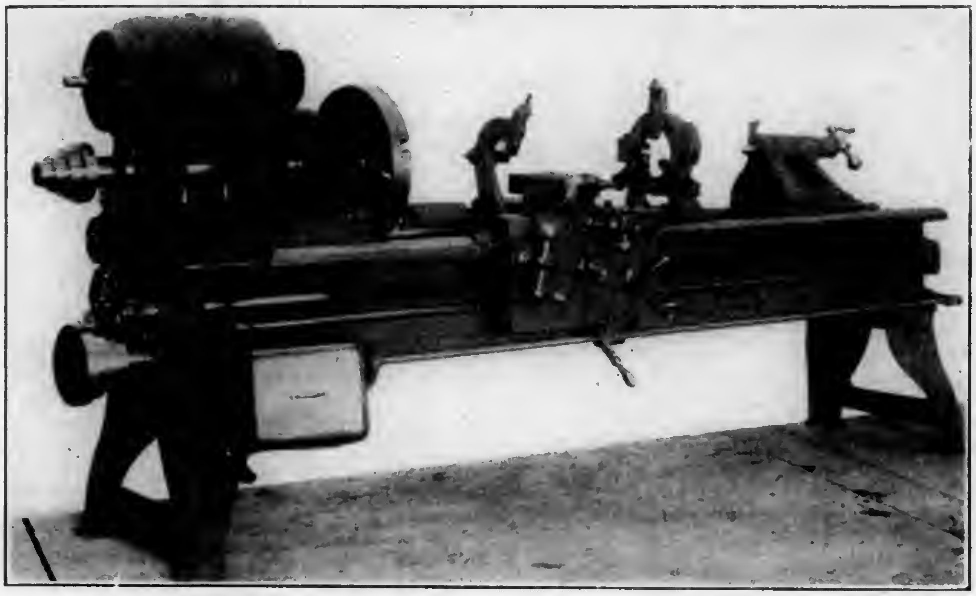
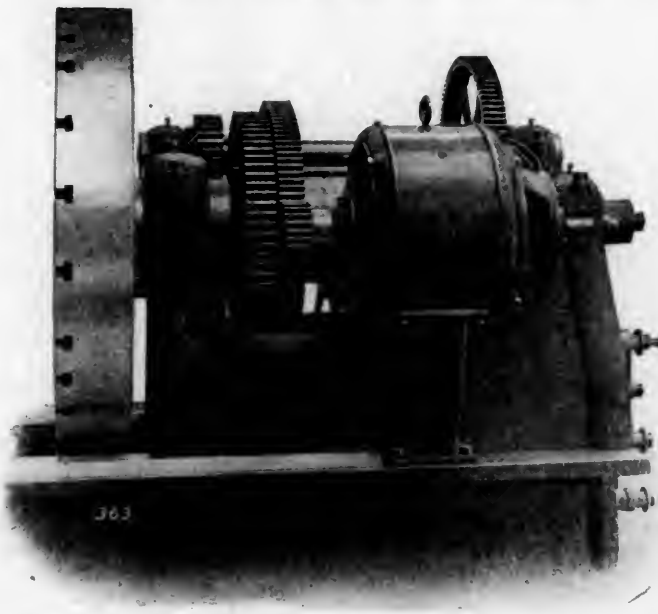
a constant-speed motor, mounted beneath the bed and driving through gearing to the headstock. The motor shown on this lathe is a three horse-power motor, of the enclosed type for protection from chips and dirt; it is not reversible, a mechanical gearing arrangement operated by a double throw clutch being provided for reversing the direction of drive. The switch and starting rheostat, which control the motor, are conveniently located on the front of the bed at the left.

Changes of spindle speed are obtained mechanically by the clutch levers projecting from the head under the guard hood.



GEARED DRIVE FOR A LE BLOND ENGINE LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.



GEARED DRIVE FOR A FITCHBURG LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

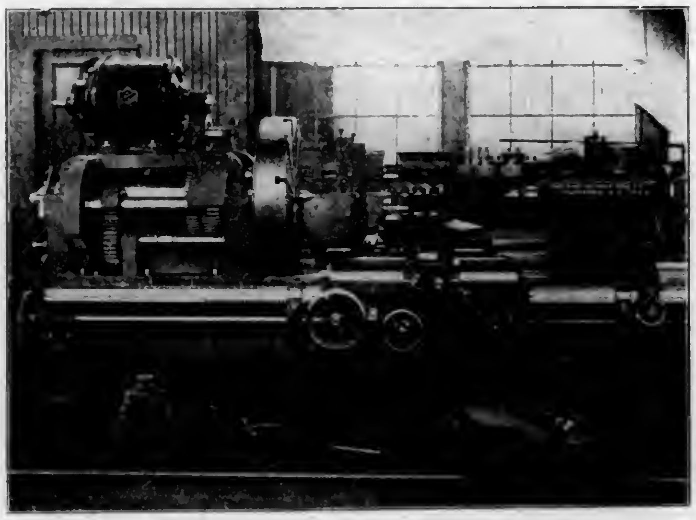
The lathe is started, stopped, or the motion reversed, and at an accelerated speed, entirely independent of the motor, by a lever attached to the apron, always convenient to the operator; this lever operates the double-throw clutch in the gear reversing arrangement beneath the bed. By means of the four different speed runs of gearing in the head and the back gear, eight even changes of spindle speed are afforded, varying from four to 284 revolutions per minute.

The following illustrations of motor-driven lathes present examples of lathes driven by variable-speed motors, and will indicate what has been done in this branch of motor application. A variety of attempts have been made toward the desired result—to combine simplicity and flexibility in the mounting of the motor and the drive to the spindle, but with varying success. The following examples represent applications of Bullock motors to operate upon the multiple-voltage system (four wire) of the Bullock Electric Manufacturing Company, Cincinnati, O. Controllers are used in all of these cases, which affords from 12 to 26 different speeds at the motor, as well as its reversal with 6 speeds. All of these equipments have proven very serviceable and have given perfect satisfaction.

The first example, shown herewith, is a drive for an 18-in. engine lathe, built by the R. K. Le-Blond Machine Tool Company, Cincinnati, O. The motor is, in this case, mounted directly above the headstock upon short brackets cast as a part of the headstock frame. In this way the alteration of the lathe was reduced to a minimum and a most direct drive obtained.

The drive is by gears direct to the spindle, with changes of gearing to provide for additional changes of speed. As may be noticed, the controller is mounted horizontally upon the bed below the headstock, and provided with a long splined shaft extending beneath the apron so as to be rotated, and the motor's speed changed, by a handle permanently located upon the carriage.

At the left is illustrated a similarly arranged drive upon a Fitchburg lathe, the motor being in this case located at the rear of the headstock instead of above. The motor support consists of a small special bracket of neat design bolted to the headstock frame and conforming to the contour of the field magnet ring. The drive is also in this case through gearing to the spindle, back gears and runs of gearing permitting further changes of speed.



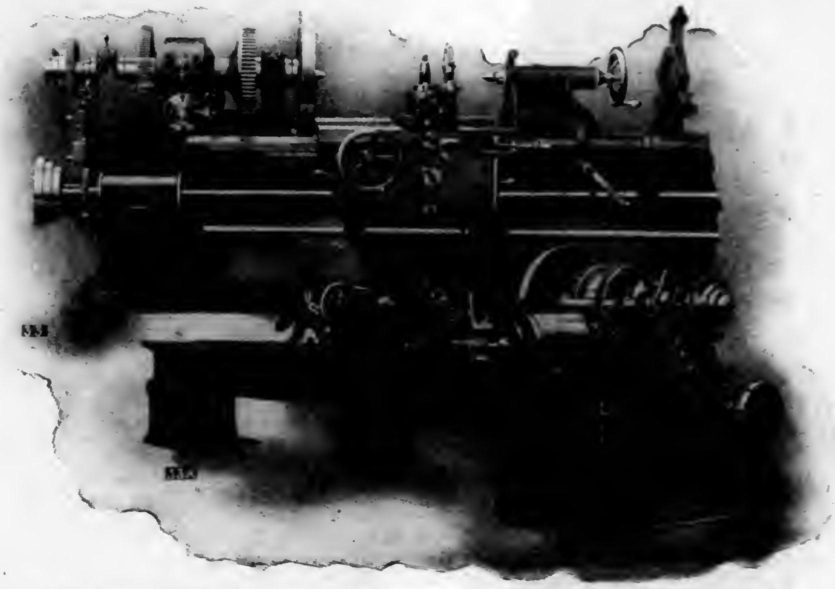
GEARED DRIVE FOR A 36-IN. POND LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

The engraving on page 139 presents a different arrangement of the motor for the drive. The lathe in this case is an American Tool Company's cabinet lathe with a special headstock arranged for the motor drive, a Bullock type N motor. The motor is mounted upon a special pedestal bracket at the rear of the headstock, with its shaft at right angles to the lathe's spindle; the bracket is of box-shape construction bolted to the rear of the lathe bed and partly resting upon the floor. The drive is through a pair of spiral gears to the spindle direct, giving a single-speed reduction—a very simple, though ef-

fective arrangement. The motor control is, in this case as in that of the LeBlond lathe, through the controller, located on the front of the bed and operated through the agency of a splined shaft by a handle permanently mounted on the apron. The range of speed thus afforded is further extended by the usual back-gear.

The type of motor mounting favored by the Pond Machine Tool Company is shown on the 36-in. motor-driven Pond lathe illustrated on page 138. It is the type of motor mounting which is used at the Collinwood shops installation and has been found highly satisfactory. The motor, also a Bullock motor, is supported by a frame spanning the headstock frame, several runs of gears being interposed in the drive to the spindle to furnish additional ranges of speed.

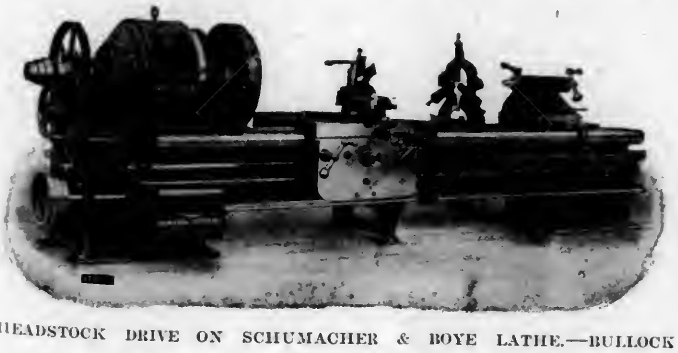
A similar arrangement of motor is presented by the cut immediately below, which shows a Bullock motor mounted to drive a Schumacher & Boye engine lathe. The motor mounting is provided in this case by lugs cast on the headstock frame to which the motor is bolted.



SPECIAL SPIRAL-GEAR DRIVE FOR AMERICAN TOOL COMPANY'S CABINET LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

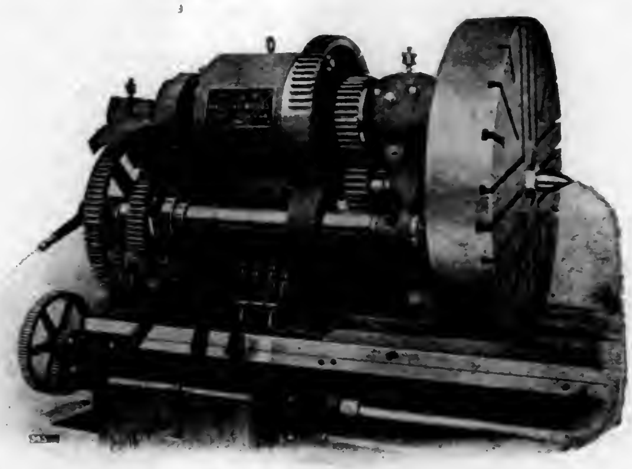
The two remaining cases, shown below, illustrate motor drives in which the motors are built into the headstock. One is a Fitchburg lathe and the other one a Schumacher & Boye lathe, both motors being Bullock multiple voltage motors. This arrangement results in a very compact and convenient mounting for the motor, but it introduces an inherent defect by virtue of the lack of ready interchangeability of

GEARED DRIVE ON A SCHUMACHER & BOYE LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING CO.



HEADSTOCK DRIVE ON SCHUMACHER & BOYE LATHE.—BULLOCK MOTOR.

motors; when a motor is thus built into a headstock, with its armature shaft serving as the spindle or as a back-gear, it necessarily requires considerable time to replace it by another motor in case of accident or necessary repairs. For this reason



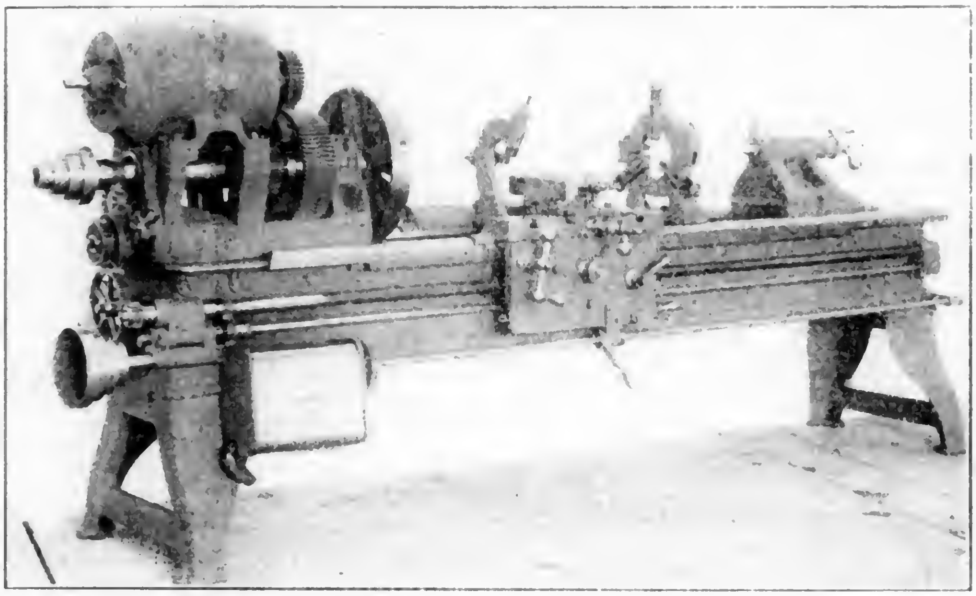
HEADSTOCK DRIVE ON A FITCHBURG LATHE.—BULLOCK MOTOR.

the Bullock Company do not advocate this arangement, preferring the previously illustrated cases in which an entirely standard motor is used, so as to be readily replaced if necessary by one of a similar dimension.

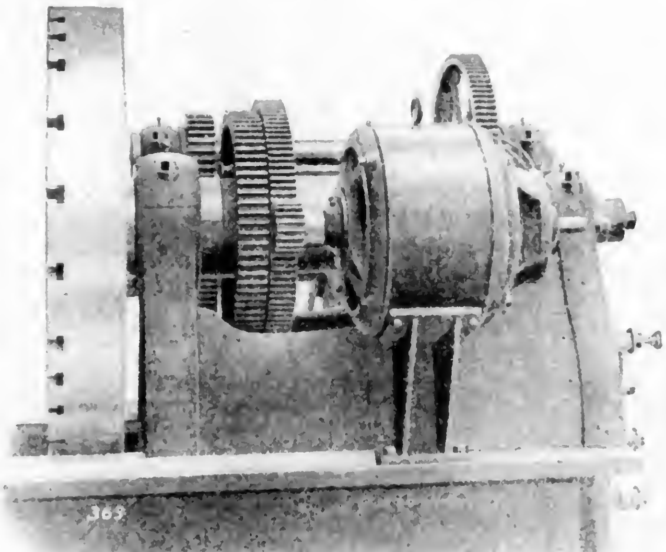
The Simplon tunnel is progressing rapidly. According to Consul Pearson (Genoa), about 4,000 workmen are employed in the tunnel, and not less than 6,000 on the Italian section of the road between Isella, at the mouth of the tunnel, and Arona, the present terminus of the railway running north from Milan. It is now practically certain that the road will be completed by July 1, 1905. The greatest of the impediments was the ever increasing heat in the tunnel, caused by the growing volume of water, which, although it starts at the summit of the mountain, 6,000 feet above the line of railway, after percolating through beds of limestone, becomes almost boiling hot and flows into the tunnel at a temperature of from 112 deg. to 140 deg. Fahr., rendering not only work but life impossible, without resort to artificial means of refrigeration. The engineer, by turning cold air on hot air and cold water on hot water, has reduced the temperature in the tunnel from 140 deg. to 70 deg. Fahr. The volume of water flowing out of the south end of the tunnel is over 15,000 gals. per minute and furnishes motive power sufficient not only to work the refrigerating apparatus, but to compress the air by which the drills are operated. This tunnel, when completed, will be the largest in the world—to wit, 14 miles long, or twice the length of the Mont Cenis and 5 miles longer than the St. Gothard. The cost of the tunnel alone will be $13,510,000, an average of nearly $1,000,000 per mile.

a constant-speed motor, mounted beneath the bed and driving through gearing to the headstock. The motor shown on this lathe is a three horse-power motor, of the enclosed type for protection from chips and dirt; it is not reversible, a mechanical gearing arrangement operated by a double throw clutch being provided for reversing the direction of drive. The switch and starting rheostat, which control the motor, are conveniently located on the front of the bed at the left.

Changes of spindle speed are obtained mechanically by the clutch levers projecting from the head under the guard hood.



GEARED DRIVE FOR A LE BLOND ENGINE LATHE.—MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.



GEARED DRIVE FOR A FITCHBURG LATHE.—MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

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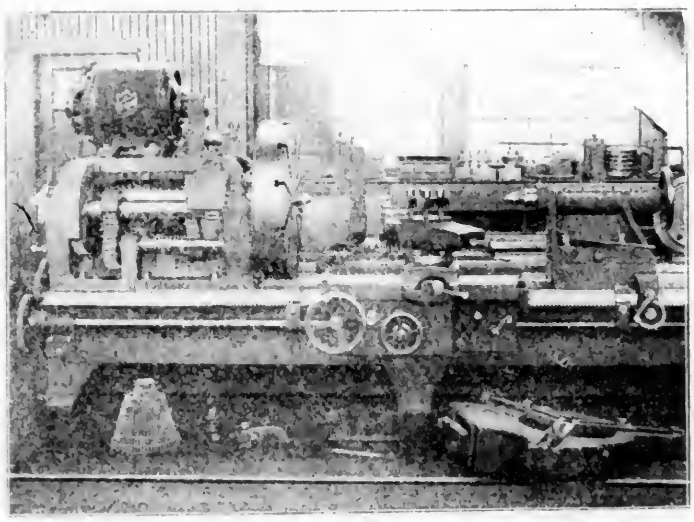
The drive is by gears direct to the spindle, with changes of gearing to provide for additional changes of speed. As may be noticed, the controller is mounted horizontally upon the bed below the headstock, and provided with a long splined shaft extending beneath the apron so as to be rotated, and the motor's speed changed, by a handle permanently located upon the carriage.

At the left is illustrated a similarly arranged drive upon a Fitchburg lathe, the motor being in this case located at the rear of the headstock instead of above. The motor support consists of a small special bracket of neat design bolted to the headstock frame and conforming to the contour of the field magnet ring. The drive is also in this



GEARED DRIVE FOR A 36-IN. POND LATHE.—MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

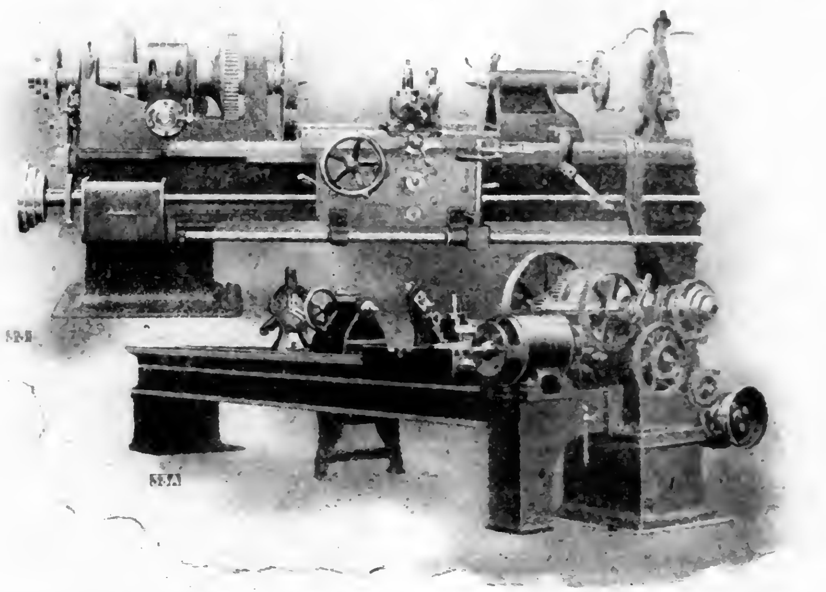
case through gearing to the spindle, back gears and runs of gearing permitting further changes of speed.

The engraving on page 139 presents a different arrangement of the motor for the drive. The lathe in this case is an American Tool Company's cabinet lathe with a special headstock arranged for the motor drive, a Bullock type N motor. The motor is mounted upon a special pedestal bracket at the rear of the headstock, with its shaft at right angles to the lathe's spindle; the bracket is of box-shape construction bolted to the rear of the lathe bed and partly resting upon the floor. The drive is through a pair of spiral gears to the spindle direct, giving a single-speed reduction—a very simple, though ef-

tive arrangement. The motor control in this case as in that of the LeBlond the, through the controller, located on front of the bed and operated through agency of a splined shaft by a handle rmanently mounted on the apron. The nge of speed thus afforded is further exded by the usual back-gear.

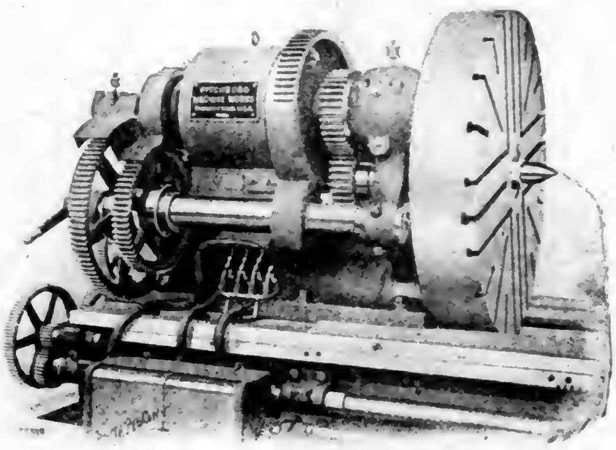
The type of motor mounting favored the Pond Machine Tool Company is own on the 36-in. motor-driven Pond the illustrated on page 138. It is the type motor mounting which is used at the llinwood shops installation and has been found highly satisfactory. The motor, also a Bullock motor, is supported a frame spanning the headstock frame, veral runs of gears being interposed in the drive to the spindle to furnish addional ranges of speed.

A similar arrangement of motor is presented by the cut immediately below, which shows a Bullock motor mounted to drive a Schumacher & Boye engine lathe. The motor mounting is provided in this case by lugs cast on the headstock frame to which the motor is bolted.

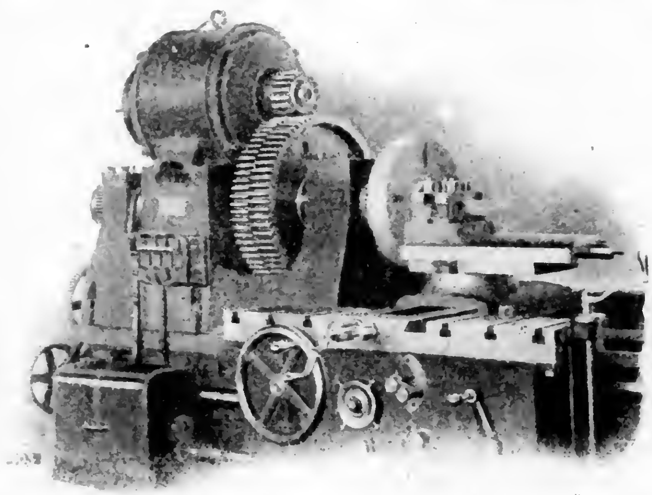


SPECIAL SPIRAL-GEAR DRIVE FOR AMERICAN TOOL COMPANY'S CABINET LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

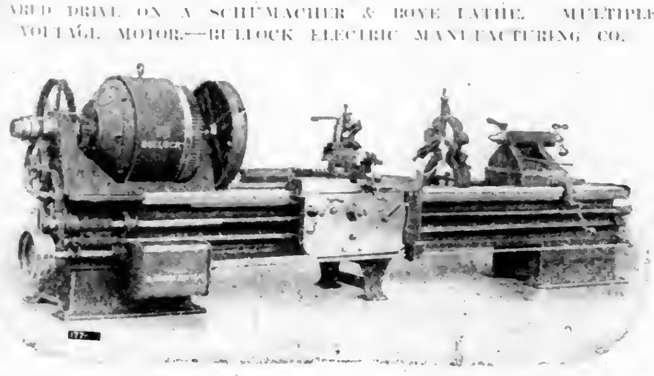
The two remaining cases, shown below, illustrate motor drives in which the motors are built into the headstock. One is a Fitchburg lathe and the other one a Schumacher & Boye lathe, both motors being Bullock multiple voltage motors. This arrangement results in a very compact and convenient mounting for the motor, but it introduces an inherent defect by virtue of the lack of ready interchangeability of motors; when a motor is thus built into a headstock, with its armature shaft serving as the spindle or as a back-gear, it necessarily requires considerable time to replace it by another motor in case of accident or necessary repairs. For this reason the Bullock Company do not advocate this arrangement, preferring the previously illustrated cases in which an entirely standard motor is used, so as to be readily replaced if necessary by one of a similar dimension.



HEADSTOCK DRIVE ON A FITCHBURG LATHE.—BULLOCK MOTOR.



GEARED DRIVE ON A SCHUMACHER & BOYE LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING CO.



HEADSTOCK DRIVE ON SCHUMACHER & BOYE LATHE.—BULLOCK MOTOR.

The Simplon tunnel is progressing rapidly. According to Consul Pearson (Genoa), about 4,000 workmen are employed in the tunnel, and not less than 6,000 on the Italian section of the road between Isella, at the mouth of the tunnel, and Arona, the present terminus of the railway running north from Milan. It is now practically certain that the road will be completed by July 1, 1905. The greatest of the impediments was the ever increasing heat in the tunnel, caused by the growing volume of water, which, although it starts at the summit of the mountain, 6,000 feet above the line of railway, after percolating through beds of limestone, becomes almost boiling hot and flows into the tunnel at a temperature of from 112 deg. to 140 deg. Fahr., rendering not only work but life impossible, without resort to artificial means of refrigeration. The engineer, by turning cold air on hot air and cold water on hot water, has reduced the temperature in the tunnel from 140 deg. to 70 deg. Fahr. The volume of water flowing out of the south end of the tunnel is over 15,000 gals. per minute and furnishes motive power sufficient not only to work the refrigerating apparatus, but to compress the air by which the drills are operated. This tunnel, when completed, will be the largest in the world—to wit, 14 miles long, or twice the length of the Mont Cenis and 5 miles longer than the St. Gothard. The cost of the tunnel alone will be $13,510,000, an average of nearly $1,000,000 per mile.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

THE "AMERICAN ENGINEER" TESTS.

The investigation of the portion of this subject relating to stacks has been completed, and the conclusions reached by Professor Goss are at hand and will be printed in forthcoming numbers of this journal. It is appropriate to remark at this point that this research is undoubtedly the most complete and thorough which has been made up to this time in connection with locomotive draft appliances. The Master Mechanics' Association committee of 1896 brought exhaust pipe design out from the unknown, and the present tests appear to have done the same for stacks. These experiments establish the correct stack and front-end relationships for the relatively small locomotive at Purdue, and the formulæ there obtained are now being tested upon large locomotives upon several prominent railroads. The results will be brought before the Master Mechanics' Association in June. Upon them the character of the further pursuit of the problem will depend.

These investigations have by no means exhausted the resources of this journal, which has up to this time conducted the tests at its own expense, but the work has been brought up to a condition which has naturally led to an offer of co-operation by the Master Mechanics' Association. Last year, as a result of a suggestion by President Waitt in his annual address, a committee was appointed to study the results, consider a plan for extending the investigation, and to assist in the work. This committee will report in June, and it is the desire of the AMERICAN ENGINEER that the investigation should proceed to include other valuable and useful conclusions which now appear to be within reach.

Professor Goss has never done better or more careful work than that covered by his report, and it would be ungrateful to await the presentation of his final conclusions to acknowledge his conscientious and even self-sacrificious assistance and that of the trustees of Purdue University, which has been most generous. Earnest attention to the report of the committee is hoped for, so that the continuation of this investigation may have the interested support of all of the railroads of the United States, in behalf of which the work was originally undertaken.

THE SPECIAL APPRENTICE.

That several things are wrong with the special apprenticeship system is becoming evident to many people. In spite of the fact that technically trained young men have been available in large numbers for the past thirty years, the railroads, for some reason, do not find it easy to secure the men they need for superintendents of motive power.

One difficulty is that young technical men seldom remain in railroad service long enough to get fairly started on the road to promotion. This is a matter for immediate thought and action. One of our contemporaries expresses the opinion, held also by many railroad officers, "that the railroads should do something more than they are now doing to make the position of its special apprentice more attractive." The AMERICAN ENGINEER does not take this view.

There is something about technical education which makes it difficult, and many times impossible, for a young man to be patient. Instead of constantly reminding the graduate that he is supposed to be specially well prepared for advancement, should he not be led to forget that he has had any "advantages?"

The position of superintendent of motive power is the one which needs to be made more attractive. When this position is made what it ought to be, young men will prepare more patiently to fill it. Technically educated men could then enter with confidence upon a long time service. If they enter it with a view of rising because of actual results accomplished there will soon be men enough for all the positions.

By way of a practical suggestion with reference to the special apprentices who have served their time, why not create new positions, such as assistant foremen in the shop and in the roundhouse? If this can be done, many of these young men may be saved to railroad service.

COMMUNICATIONS.

THIRTY-TON BOX CAR WITH STEEL UNDERFRAME.

To the Editors:

Referring to the criticisms of the 30-ton steel-underframe box car in the January issue of the AMERICAN ENGINEER AND RAILROAD JOURNAL, page 18, the writer feels it incumbent upon himself to reply as follows:

Regarding Mr. Reynolds' first question (February number, page 52), as to whether it would not be better construction to use pressed steel sills instead of structural, it seems to me that this is going somewhat beside the question. The underframe was designed as a structural underframe, and the matter of whether or not a fundamentally different type would be better for the purpose is hardly in question. Neither do I see that his suggestions regarding the desirability of using wooden sills point the way to a proper solution of the underframe problem, because experience has tended to prove that the wooden sill substructure is not sufficiently strong for freight-car service. Particularly is this true with respect to pulling and buffing shocks; less so, of course, from the standpoint of vertical loads.

Concerning latticing top flanges of center sills, and not the bottom, it should be answered that this is proposed to meet the objections of a great many railroad men to punching holes in the tension flanges of longitudinal sills. There is no doubt about the fact that, considered as a column, the central backbone of the car would be much stiffer with cover plates top and bottom, but neither these nor lattice bars were shown on the bottom flanges for the reason that they are not believed to be absolutely essential. What proportion of a 300,000-pound blow on the drawbar would be sustained by the center sills, the writer frankly confesses he does not know; he doubts whether it can be determined even approximately in a car frame, and is therefore disposed to be guided by experience in this particular matter.

The designer readily agrees that the section shown for the bottom member of the body bolster may be less than the best practice would indicate to be desirable; his only reason for this is that the drawing was not presented as a finished example, but was prepared hurriedly with a view to illustrating a type, rather than as a fully worked out case, complete in all details. It would undoubtedly be better to strengthen the compression member in the manner suggested by Mr. Reynolds, or by using a heavier bar.

The writer is not sufficiently familiar with the actual conditions obtaining in the transportation of such materials as are preferably carried in box cars, to hazard the statement that an all steel box car would be better than steel underframe equipment with a wooden superstructure. I imagine that under certain atmospheric conditions a great deal of moisture would condense on the inside walls of a steel box car, which might be injurious to many commodities.

Noting Mr. Kennington's criticisms of the method of attaching truss rods to the body bolsters, I think if he will examine the design a little more carefully he will see that there is little likelihood of failure at the point mentioned, for the reason that the ⅞-in. rivets pass through the top bolster member as well as the large gusset plate, and in addition, the truss rod bolster straps are anchored up at the ends to afford a bearing against the top member of the transom.

The writer does not understand why it is impossible to hold the end of the car down against the end gusset plates over the center sills. As the end frames would be provided with the usual rods, and, in addition, a wooden sub-sill could be used, which offers every opportunity to secure it by bolts to the underframe, I do not see that there should be much difficulty to accomplish this result.

There is no doubt that if the corner gussets were riveted to the end sills as well as to the side sills, they would help to stiffen the frame against distortion when poling; the reason this was not done is to have the end sills as free as possible from any rivets that would be difficult to remove in case new end sills were necessary. Moreover, since wooden cars are usually built without any diagonals, and are not seriously distorted, it is believed the scheme shown is sufficient for this purpose.

The writer agrees with Mr. Kennington that it would not be entirely satisfactory to use the underframe illustrated for flat or gondola cars without suitable modifications. As this was never the intention, it is hardly necessary to say more than that there would be no difficulty whatever to adapt the details to suit different classes of cars without departing in any essential particular from the general style of construction.

Permit me to say in closing that the only important features of this design which are advocated, is the use of *trussed structural steel sills* rather than pressed steel fish-bellied girders, or untrussed structural sections sufficiently strong in themselves to carry the given load; also, the general type of body bolster, end sill, and arrangement, as a whole, of the several parts. Dimensions of details and their precise location would have to be modified to suit special requirements. From this point of view, the writer maintains that his style of underframe is very well adapted to meet the severest conditions of modern train service.

GEORGE I. KING.

WHAT "BIG ENGINES" MEAN.

Cincinnati, Ohio, March 16, 1903.

To the Editors:

In the March issue of the AMERICAN ENGINEER AND RAILROAD JOURNAL a descriptive article appeared describing some new locomotives recently built by the Baldwin Locomotive Works for the Chicago & Alton Railroad. An editorial entitled "What Big Engines Mean" appears in the same issue in conjunction with this article. The editorial says that these engines were built to do a certain definite work, which the most powerful passenger engines previously built could not do. The point is also brought out that the motive power of railroads in general is fast assuming proportions with which it is difficult to cope with the present shop facilities. This is a condition which naturally exists when any line of mechanical business is on the increase. It is, of course, especially true in railroad work. The management is interested primarily in the output, or the work done. The facilities for doing this work are more or less secondary and always follow.

No one with any knowledge of existing conditions or of the history of past development of railroad work, and mechanical work in general, would venture to make a prophecy as to the limit in size of locomotives, or in fact any class of machinery. There may be, however, a limiting condition which will have a decided influence upon the size of locomotive units. It does not require a very great stretch of the imagination to see passenger service of all the heavy trunk line roads divided up into small units, these units being propelled by electricity, which is generated in stationary plants. This would make possible an economical operation of small units impossible with the present propelling power. Looking forward to this condition, of course, does not meet with the favor of a great many interested parties, but it is sure to come.

The writer, in conversation with the chief engineer of the New York Manhattan Elevated Railroad exactly six years ago, expressed the opinion that the elevated trains would be operated by electricity by a system in which each car would supply its own motive power. The expression of this idea provoked a rather sarcastic smile on the countenance of the chief engineer. His reply was to the effect that they were doing certain work with a certain amount of fuel and attendance, and "how could you hope to improve upon that condition?" It is needless to comment on this matter further, as the millions of dollars which this company is expending for this equipment is conclusive evidence that there must be improvement hoped for somewhere. Can we not reasonably hope to see the passenger service of the principal railroads throughout the country handled on a similar plan to the one in use on the Manhattan Elevated Railroad?

There are, however, many modifications and improvements that can be made in applying this method of propulsion to railroads, among which might be mentioned the possibility of making head-on and tail-end collisions an impossibility. This could be easily accomplished by cutting the line into sections and so arranging that there must be one dead section between each two trains at all times. A train or a car entering this dead section will not only be deprived of its power, but will have all of its braking power applied instantly. Such an arrangement would make very high speeds possible, feasible and safe.

The concentration of such enormous weights in trains, which are to be propelled at a high speed, makes the question of retardation one of very great importance and is certainly fraught with many difficulties and no small degree of danger. The advantages of the reduction of weight of the moving mass to a minimum are too well known to need any explanation. The question of how this is to be accomplished is a matter of development. This development is rapidly taking place and there will certainly be some radical changes in the near future.

W. COOPER.

THE DAVIS COUNTERBALANCE.

To the Editors:

Mr. Fetters' statement of the action of counterbalance weights in his letter on the Davis Counterbalance is correct.

There is nothing which can be accomplished by the Davis system which cannot be accomplished by the Master Mechanics' method as outlined in the 1896 and 1897 reports; if the same proportion of the reciprocating parts are used to determine the needed counterbalance weights. If any superiority has been shown for the Davis system I should suspect some form of comparison had been made with some engine on which the exact state of the counterbalance weights had either not been determined or had not been corrected before the test.

The only other possibility I see is that if the Davis balance compels a heavier wheel owing to the scheme of location used, one pound added to counterbalance the reciprocating parts would have less effect than on a lighter wheel, as the disturbance caused by any weight is inversely as the mass on which it acts. It will be remembered that in Attwood's machine for demonstrating the law of falling bodies that where the two weights designated as "P" were suspended by a cord and exactly balanced on a pulley, one weight, "P," at either end of the cord, when the small weight designated as "p" was added to one side it fell, not freely like any ordinary body, but with decreased acceleration, according to the formula $\frac{p}{2P + p}$, or inversely as the mass.

The writer has had it stated to him that engines which had had the size of the wheel increased by leaving on $1\frac{1}{2}$ ins. of the old tire as a rim, rode better than formerly at high speeds. If they did I should explain it by the above, as the counterbalance was not touched. This proposition could be probably demonstrated better if a small model were used than in actual practice, as the model would allow a variation of proportion not met with or feasible in practice.

X. Y. Z.

St. Louis, March 14, 1903.

To the Editors:

I am much interested in an article that appears on page 108 of your issue of March over the signature of Mr. A. H. Fetters. It is not a great while since that I received a letter from a prominent superintendent of motive power and machinery, from which I wish to quote as follows:

"I am of the opinion that the rules adopted by the Master Mechanics' Association pretty thoroughly cover the counterbalance question, *and while it is true that they do not provide a perfect counterbalance*, it is certainly true that our modern engines are giving us no trouble.

"Your circular about Davis driving wheels states that the weights determined under the Master Mechanics' Association rules are placed at each of the two points located at an angle of 120 degrees from the crankpin, and it is claimed that in this location the centrifugal forces due to the revolving weights counteract each other.

"*Now, as a matter of fact, the centrifugal forces of these two counterbalances act exactly as the resultant would act, and it can be proven that the resultant is equal in force and direction to the centrifugal forces due to our counterbalance as at present located;* therefore it is evident that the Davis system calls for twice the counterweight in a wheel center that we now put in, and with no improvement in the balance."

The italics in the above quotation are mine, and are given to emphasize the statement made by Mr. Fetters wherein he calls attention to the fact that the resultant as between the center of gravity of the weights A and B is at the point C, being the middle of a straight line connecting the two centers of gravity, and 180 degrees from the crank.

Mr. Fetters, I think, has overlooked the same important point that the superintendet of motive power overlooked when he wrote me the letter from which I have quoted as above, in that it necessarily follows that if there is the resultant effect mentioned as between the weights A and B, there is the same resultant effect as between the center of gravity of the crankpin and its weight, and the counterbalance weight B as between the two counterbalance weights A and B; and if there is this resultant between the center of gravity of the crankpin and the center of gravity of the weight B, then there is a similar resultant as between the center of gravity of the crankpin and its weights and the center of gravity of counterbalance weight A, yielding a correct distribution of weights necessary for a correctly counterbalanced wheel; and when the attention of the superintendent of motive power was called to this fact he admitted the force of the argument and has a set of wheels in use and is specifying the Davis wheels under his locomotives as he orders additional power, as a direct result of the practical experience had from using the wheels.

The time was when all the wise men of the world insisted that the world was flat, and when the old mariner startled the world as then constituted by his statement with regard to his ability to sail around the world, they took the old man and locked him up because they said he was crazy; but after a while people broke away from their traditions of the past, and they were able to see things as this man saw them, and as a result America was discovered. America was always here, and it simply needed some man who was sufficiently receptive to the truth to discover the fact to the balance of the world.

I honestly and candidly believe that Philip Z. Davis of Texas has made a great discovery in the law that he has discovered in connection with the counterbalancing of locomotive driving wheels, and the practical experience that we are getting from the use of these wheels under the large number of locomotives equipped with them to-day serves to establish this fact, and all of those who try the Davis wheels express the same opinion with regard to the practical side of the question, and therefore the Davis wheel has ceased to be a theory and has become an established fact.

Mr. Fetters' article is simply a very strong endorsement of all that is claimed for the Davis wheel, in that he points out unintentionally the fact that where the counterweight is disposed 180 degrees from the crank there is absolutely no resultant force between the two revolving weights, *i. e.*, the crank and the counterbalance; but when the counterbalance is placed so that the counterbalance is always 120 degrees from the crank and the two counterbalances are necessarily 120 degrees from each other, then you have a correctly counterbalanced wheel, and it is perhaps a remarkable phenomena that you can do with three weights what you can do with four.

IRA C. HUBBELL.

3325 Washington Avenue,
St. Louis, March 12, 1903.

To the Editors:

Referring to an article in your March number by A. H. Fetters relative to the Davis method of counterbalancing, I will say that I haven't time to indulge in a technical discussion of this. However, when I was working for the 'Frisco system I had the opportunity of calipering the wheels of a ten-wheel engine equipped with this counterbalance. After being in service eighteen months the greatest difference in the lengths of diameters drawn through sixteen points on the circumference of the tire was three-one-hundredths of an inch. This same engine was frequently in the shop for tire work when equipped with the "old style" counterbalance, with tires badly worn out of round. Furthermore, persons having little or no mechanical knowledge were given rides on similar engines equipped with the two types of counterbalance, and even they were able to discern the easier riding qualities of the engine with the Davis system. These are facts.

C. E. MILLER.

Merrill Van G. Smith has been appointed associate professor of mechanical engineering by the Board of Trustees of the Clarkson School of Technology, Potsdam, N. Y., to fill tne chair made vacant by the resignation of Professor Robinson last November.

The Ingersoll-Sergeant Company are considering the installation of variable-speed motor driving equipments for the machine tools in their new Phillipsburg factory, having commissioned the firm of Dodge & Day, of Philadelphia, to investigate the subject and to thus equip a number of the large machine tools.

The General Electric Company recently secured a contract from the Interborough Rapid Transit Company to furnish 340 motors and 340 control equipments for the motor cars of that road. At the same time an order for the other half (340) of the motors was given to the Westinghouse Electric & Manufacturing Company. This control equipment is a combination of the Sprague and General Electric systems and except in a few details, is similar to that used so successfully on the Manhattan Elevated.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

BY C. W. OBERT.

IV.

The positive-drive variable speed mechanism which the American Tool Works Company, Cincinnati, Ohio, have recently applied to the new model of their 18-in. engine lathe involves an interesting design, the most important features of which are compactness, wide range of speed changes possible and ease of making changes. It will give 44 changes of feed or cut 44 different threads, each change available instantly without the removal of a single gear and without stopping the machine; the entire series can be made, each one complete and ready for work, in 30 seconds.

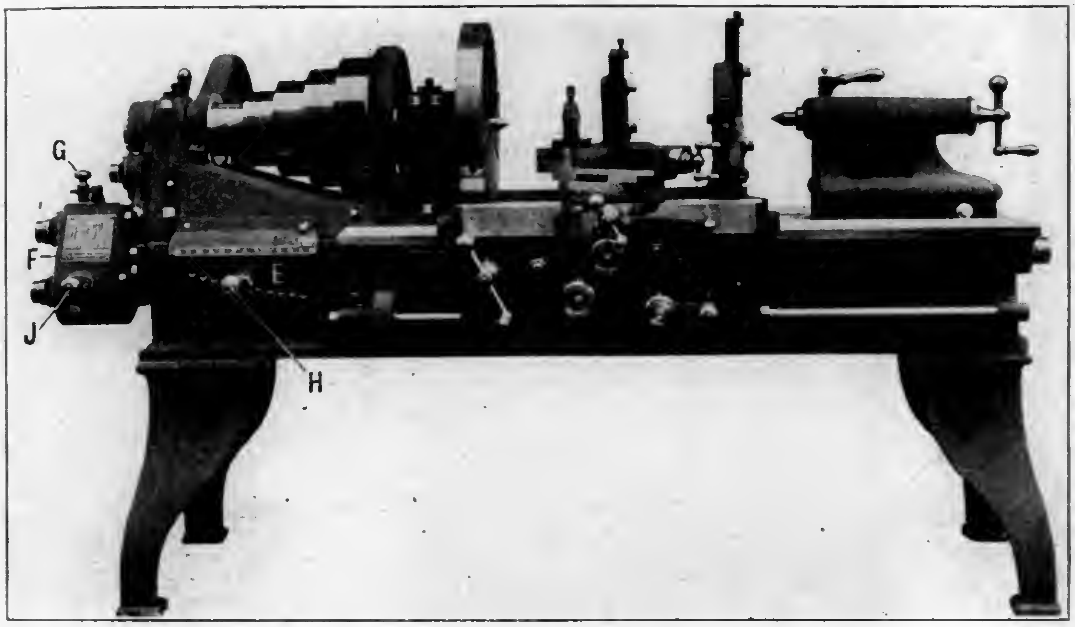


FIG. 17.—THE NEW 18-IN. ENGINE LATHE, SHOWING ARRANGEMENT OF THE VARIABLE-SPEED FEEDING ATTACHMENTS.—AMERICAN TOOL WORKS COMPANY.

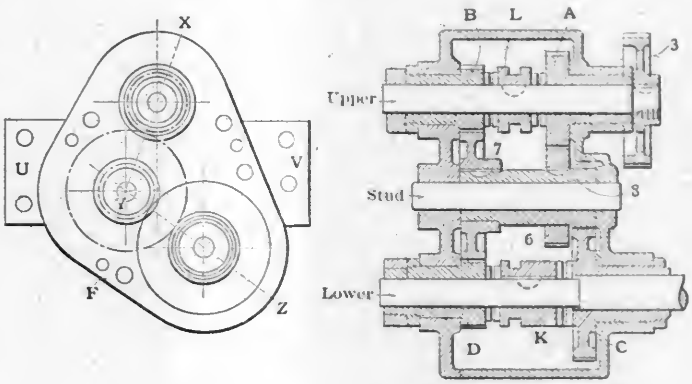
This feed-gearing attachment, like the device discussed in the second number of this series of articles, consists essentially of two distinct variable-speed mechanisms, one delivering motion to the other. The mechanism on this lathe, which receives its drive directly from the headstock spindle, is a four-speed change gear box, F (see accompanying engravings), which may, by proper adjustment of its controlling handles, G and J, deliver any one of the four speed ratios, 1 to 2, 1 to 1, 1 to ½ or 1 to ¼, to the second mechanism. The second mechanism, E, is an eleven-speed gear box of the cone of gears and movable pinion type and has a novel arrangement for bringing the pinion up into mesh with the gears of the cone.

Fig. 18 illustrates diagrammatically the principle of the four-speed mechanism, F. It consists of a cast-iron gear box arranged for bolting to the lathe bed by means of the lugs, U and V, and containing the three shafts shown in the sectional view through X-Y-Z, an upper, a stud and a lower shaft. The upper shaft receives power through the gear, 3, and is provided with a five-jaw clutch, L, by which it may be thrown into connection with either gear, A or B, by movement of the clutch handle, G, outside of the case. Gear A meshes with gear 6 and gear B meshes with gear 7, both of gears 6 and 7 being keyed to a sleeve running upon the stud shaft, so that as either A or B is in clutch the sleeve is given a fast or a slow speed.

Motion is delivered to the lower shaft either directly from gear 7 or from the gear 8, which is cut upon the end of the sleeve. Gear 8 meshes with gear C and gear 7 with D, so that at whatever speed the sleeve is running, C receives a slow speed and D a high speed from it. The lower shaft, upon which C and D loosely revolve, is fitted with a five-jaw clutch, K, similar to the upper clutch, by means of which it may be thrown into connection with either of gears C or D by proper movement of lower clutch handle, J.

Thus it may be seen that as the sleeve on the stud shaft may be made to revolve at two different speeds and also as it may deliver motion to the lower shaft at either of two different speeds, this device is capable of delivering four different speeds from the lower shaft by merely arranging the clutch handles, G and J, for the proper clutching. The handles, G and J, are clearly indexed outside the box to show what position connects their clutches with gears A or B and C or D. The clutch jaws are of steel, and all the gears in this device are cut from solid steel blanks, all being made very strong so as to be capable of safely withstanding the shock of being suddenly thrown on feed or the feed changed while the tool is taking a heavy cut.

The second gear mechanism, E, is located within the bed of the lathe beneath the headstock, as shown in Fig. 19. It consists of the cone, Q, of eleven gears keyed in order of size upon a shaft and a sliding tumbler pinion, P, which may be placed in mesh with any of them. Power is delivered to this mechanism through the splined shaft W, which is an extension of the lower clutch shaft of the four-speed gear mechanism. Upon this shaft is feathered a sleeve carrying a gear, O, which meshes with and drives the tumbler pinion P; the tumbler pinion is carried by a rocking frame, R, which is mounted upon the sleeve, as shown in the sectional view at M-N. The sleeve acts as a revolving support for the frame R, which carries the pinion, P, at the rear and is extended out at the front through an inclined slot in the front of the bed by means of a gooseneck-shaped extension.



Section through X-Y-Z

FIG. 18.—THE FOUR-SPEED CHANGE GEAR MECHANISM.

The method of changing the gear ratios of this mechanism is simply that of lowering pinion P out of mesh with the cone Q, which is accomplished by unlocking handle H, outside the frame, and raising it slightly, after which the whole frame is moved along, carrying with it the sleeve and gear O, until P

is in line with the desired gear on the cone. The proper position of the handle H for the proper meshing of pinion P with any one of the gears on the cone is easily determined by the numbered index and the locking holes at E, as shown in Fig. 17; the handle H needs only to be brought under the number corresponding to the cone gear desired and its pull-pin dropped into the locking hole below that number.

Fig. 20 shows diagrammatically the principle of the drive from the lathe's spindle through both gear mechanisms to the lead screw gear T within the bed and thence to the splined feed rod outside which is driven from it. The gear S on the lathe's spindle drives the upper shaft of the four-speed mechanism through intermediate gears 1 and 2. The lower shaft of this mechanism is extended through and used as the driving shaft, W, of the eleven-speed mechanism, while the gear on the end of the gear-cone shaft drives the lead screw directly. The arrangement of the pull-pin in handle H and of the locking holes is also clearly shown in this drawing.

The result of the use of this combination feeding mechanism is extreme simplicity for the operator when cutting screw threads. A simple but complete index plate is attached to the lathe which shows at a glance the arrangement of knobs necessary for the two mechanisms in order to obtain any one of the 44 different threads within its range. A fac-simile of the index plate is reproduced below to indicate its extreme simplicity.

Each one of the double columns labeled A-D, B-D, etc., presents the combinations possible with any one of the four speeds to be had from gear box F. Thus, with combination B-C in gear box F (the slowest speed obtainable from it), by placing knob H in locking hole 5 of mechanism E, 22 threads will be obtained per inch; if placed in hole 9, 28 threads per inch will result, and so on. It is very simple, involving, as it does, no changing of gears, and above all is extremely quickly handled.

Particular stress should also be laid upon the exceptional producing capacity of the lathe. The steel gears and extremely strong construction enables the lathe to easily withstand the heavy duty imposed by the fast cutting speeds and heavy feeds attending the use of the new high-speed tool steels, and this has been demonstrated by frequent tests on the new lathe. These tests were taken on 50 point carbon steel with the following cuts: ¼ in. deep at feed of ⅛ in. per revolution of spindle; cut ⅜ in. deep at feed of 1-16 in. per revolution of spindle; cut ⅝ in. deep at feed of 1-32 in. per revolution of spindle. These cuts were taken at a cutting speed of 60 ft., but on lighter cuts speeds as high as 150 ft. were maintained. This is remarkable work for an 18 in. lathe. The builders, gratified at the signal success attending the introduction of this size of the "American" lathe, have extended the line so as to embrace everything from 16-in. to 36-in. swing, and the designs of the other sizes are being brought through to completion as rapidly as possible.

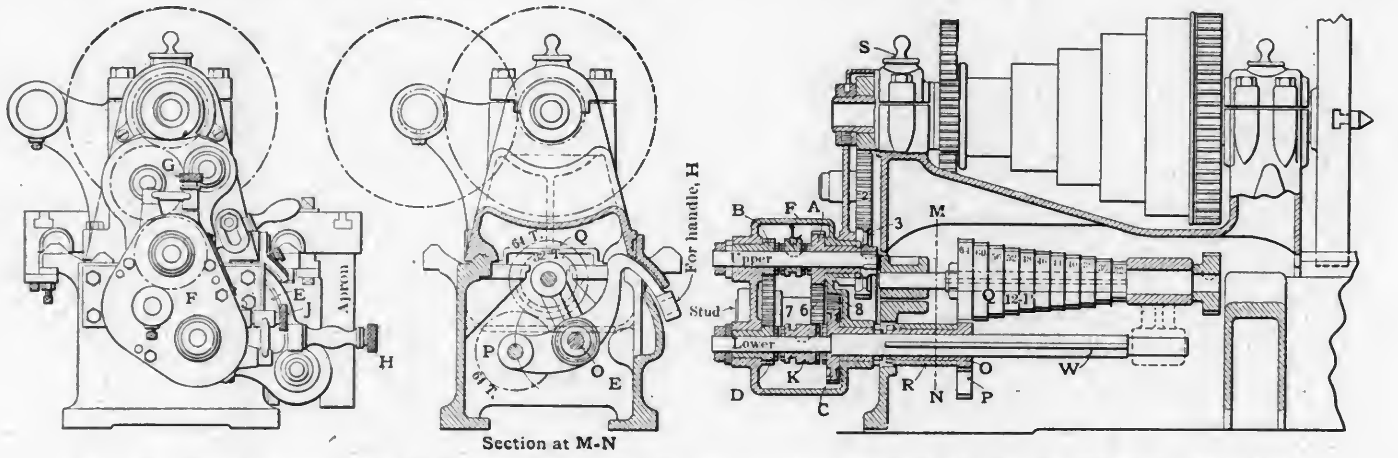


FIG. 19.—EXTERNAL END VIEW OF LATHE, AND CROSS AND LONGITUDINAL SECTIONS OF THE ELEVEN-SPEED MECHANISM WITHIN THE BED.

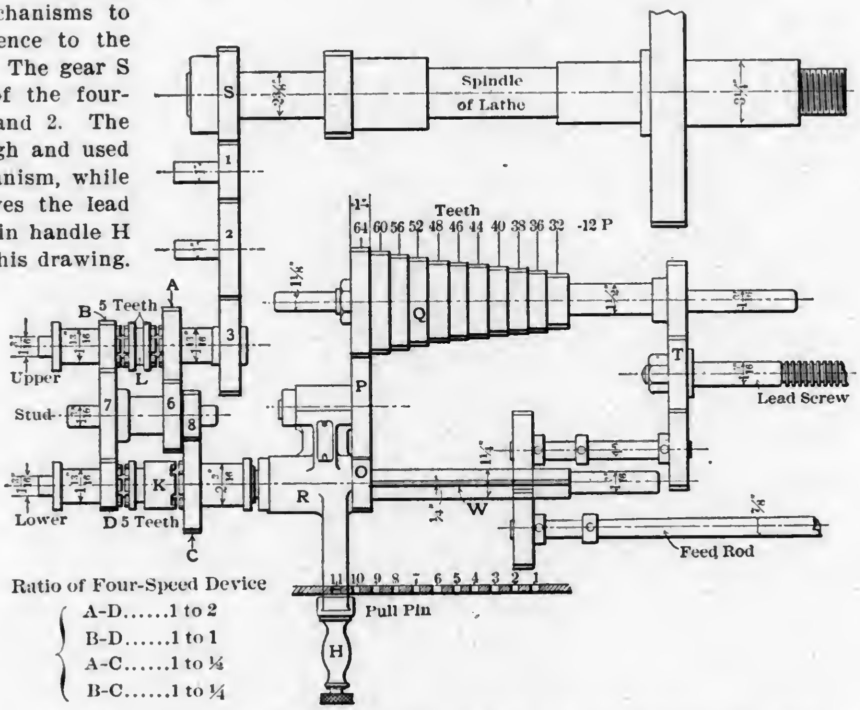


FIG. 20.—DIAGRAM ILLUSTRATING PRINCIPLE OF THE DRIVE THROUGH BOTH MECHANISMS.

ARRANGEMENT OF INDEX PLATE.

A—D		B—D		A—C		B—C	
Thds.	Knob.	Thds.	Knob.	Thds.	Knob.	Thds.	Knob.
2	1	4	1	8	1	16	1
2¼	2	4½	2	9	2	18	2
2⅜	3	4¾	3	9½	3	19	3
2½	4	5	4	10	4	20	4
2¾	5	5½	5	11	5	22	5
2⅞	6	5¾	6	11½	6	23	6
3	7	6	7	12	7	24	7
3¼	8	6½	8	13	8	26	8
3½	9	7	9	14	9	28	9
3¾	10	7½	10	15	10	30	10
4	11	8	11	16	11	32	11

FEEDS.

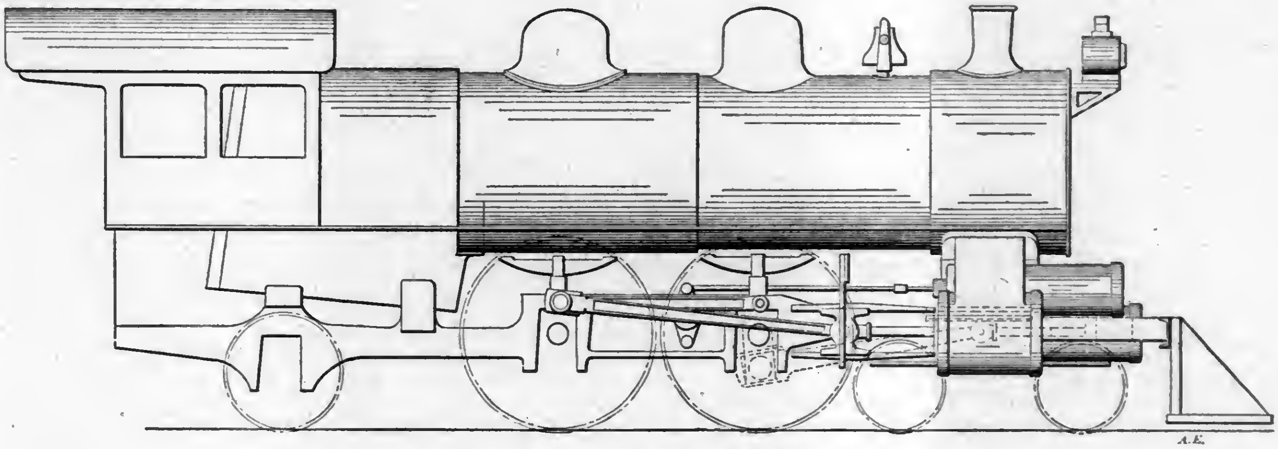
8 to 16	16 to 32	32 to 64	64 to 128

The annual engineering number of the Railway Age, of March 20, surpasses every previous special number of that or any other railway publication. It has 248 pages of text and illustrations, and in addition to matter appropriate to the meeting of the American Railway Engineering and Maintenance of Way Association, it presents in full the papers and a verbatim report of the discussions of the entire convention. Such an undertaking would stagger any other newspaper organization in this field, and THE AMERICAN ENGINEER congratulates Mr. Wilson and his staff upon the result, especially upon the 164 pages of advertising.

A NEW FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

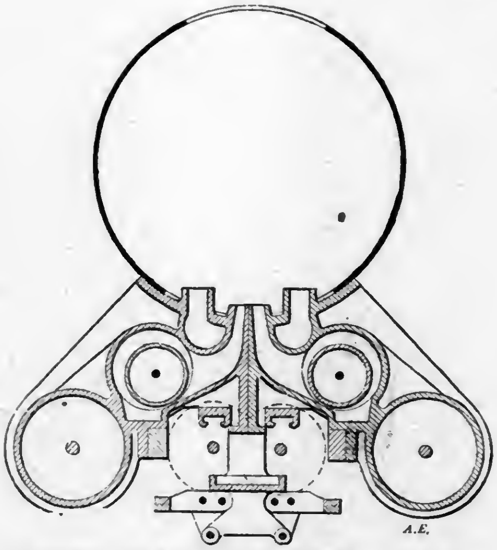
This design was developed and patented by Mr. Francis J. Cole, mechanical engineer of the Schenectady Works of the American Locomotive Company. It has not yet been put into the form of working drawings and thus far there are no plans for immediate construction, but the idea is placed on record from the patent drawing because of its interest and importance.

This plan includes long connecting rods for both high and low pressure cylinders, continuous valve chests for the high and low pressure cylinders on each side, guides for the high-



A NEW FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

DESIGNED BY FRANCIS J. COLE.



SECTION THROUGH LOW-PRESSURE CYLINDERS.

pressure cylinders supported under the saddles of the low-pressure cylinders, and the high-pressure cylinders are placed sufficiently far ahead to permit of taking out either of the pistons without interfering with the guides or any parts except the corresponding cylinder heads. A side elevation and transverse section are shown as applied to a 4—4—2 type locomotive for passenger service.

The smoke-box rests on the low-pressure cylinder saddles in the usual way and the low-pressure main rods couple to the rear driving wheels. The high-pressure cylinders are cast together and are secured to the frames, which are extended toward the front of the locomotive to receive them. They couple to the forward axle, which is cranked.

Pullman buffet parlor car service has been inaugurated on the Pennsylvania lines between Pittsburgh and Erie, Pa. This line runs through important business sections, including Newcastle and Sharon, Pa. The service will be appreciated by many business men.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

VII.

GRINDING PROCESSES FOR LOCOMOTIVE REPAIR WORK.

Grinding processes will become an important feature of the machining operations at the Collinwood shops. Several different types of grinding machines have been installed, one of which is the heavy Norton grinding machine for cylindrical work, another the Gardner disc grinder for flat surface work, and in the grinding room one 7-ft. grindstone is now in use and provision has been made for a second. Two 36-in. polishing wheels of a type made by the Railway Company, for buffing links, rods, straps and similar work, are also located there and will be supplemented by one or more buffing stands as required. In the erecting shops one electrically-driven double-head emery grinder, with emery wheels 18-in. diameter and 2-in. face fitted with the Safety Emery Wheel Company's collars, is now placed and three more of these machines will soon be in use to afford grinding facilities convenient to any of the pits. A number of other emery wheels are located around the shops so that in no case will it be necessary for a man to go far to be able to use an emery wheel in place of a file. The assured success of the grinding processes and methods of finishing work will be watched with great interest by all who are concerned with the improvement of railroad shop methods.

The Norton grinder is similar to the standard 18 by 96-inch heavy plain grinding machine made by the Norton Grinding Company, Worcester, Mass., with the exception that the table is made with a gap, allowing work 28 in. in diameter to be swung. The standard form of this machine was described in the July, 1902, issue of this journal; it will accommodate work 8 ft. between centers, and is of very heavy construction, the wheel stand slide alone weighing about 1,400 lbs., while the entire machine complete weighs about 13,500 lbs. The grinding wheel used is 24 ins. in diameter and 3 ins. thick, and in order to maintain the necessary absolutely rigid relation between the wheel axis and the work axis, the resting points are placed as near together as a uniform rigidity of the base will permit. A valuable feature of the design of this machine is that its base is a single massive casting, arranged to actually rest upon the floor in three points only (see illustrations of the machine upon page 146), so that no disturbance is possible from the settling of floors, and thus no foundation is required for it.

In changing the design of this machine to arrange for the gap permitting a 28 in. swing, it was found necessary to discard the mechanism for grinding tapers, but taper grinding will not be found a necessity in railroad repair work. The

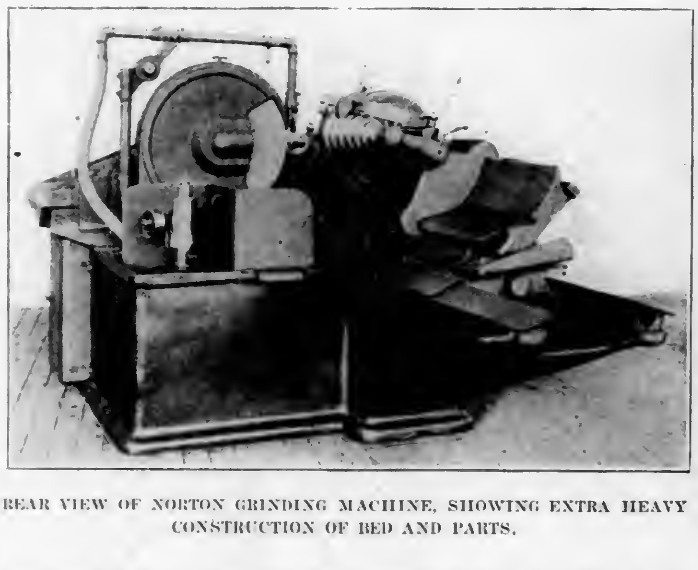
28 BY 96-IN. GAP GRINDING MACHINE.—NORTON GRINDING COMPANY. COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RY.

In trueing up piston rods that are brought in for repairs they are placed directly into the grinding machine and ground to a true cylindrical surface in 8 to 10 minutes (grinding time only), no lathe work being found necessary at all. In finishing new rods a sufficient reduction is obtained in the roughing cut in the lathe to bring the diameter down within 1-64 to 1-32 in. of that required when finished, after which it is ground down to a true surface in the grinding machine in a time almost as short as that required for the trueing-up process. It is expected that when the hoisting apparatus for handling the work into and out of the machine is installed, the total time of finishing a piston rod by grinding will amount to only fifteen minutes on the average—this including all time of handling.

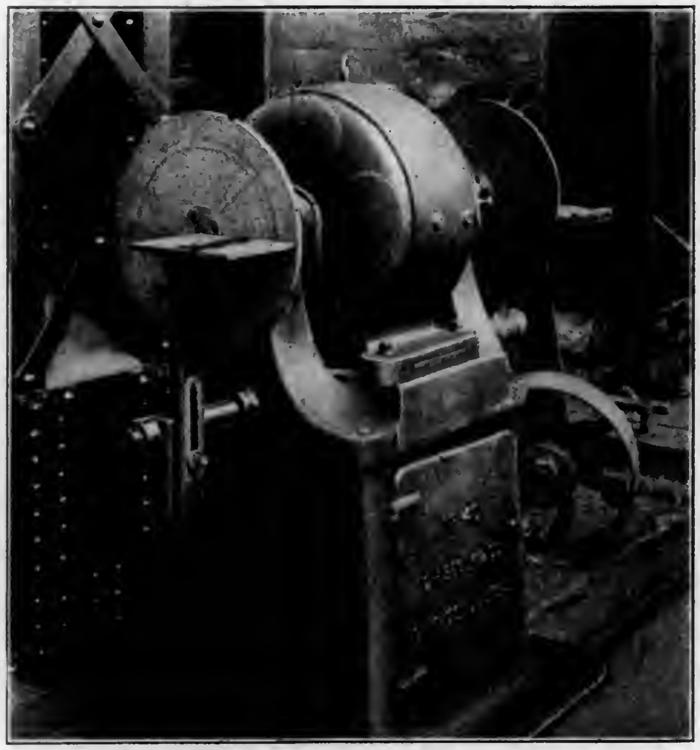
Valve stems are ground complete in from fifteen to twenty minutes, including the time required in handling, while crankpins are finished off in from five to fifteen minutes each, according to the size and shape. In all cases the usual beautifully true surface resulting from the grinding process is obtained, together with the absolute certainty of correct cylindrical shape. Mr. Vaughan, Assistant Superintendent of Motive Power, states that this work is finished by grinding at a cost of only one-sixth to one-tenth of that which would be entailed by the usual processes in the lathe.

tailstock has been somewhat changed for this machine, in that an adjustment has been provided for aligning the work straight. The grinding wheel is made with an offset to permit the wheel to traverse, when grinding piston rods, to within ⅛ in., or less, of the piston head—this will be found close enough for all practical purposes. This machine is arranged for six changes of grinding wheel speed, eight changes of speed of the work and sixteen changes of table speed, all speeds being entirely independent of each other.

A sufficient variety of work has already been done on the Norton grinder to fully demonstrate its utility in repair work. Piston rods, valve stems, and crank pins, have been finished by grinding in record-breaking time. The hoisting apparatus which is to be placed over this machine to facilitate the handling of heavy parts, such as piston rods with pistons in place, is not yet installed, so as to enable the total times required for certain finishing operations, including hoisting onto the table and removing, to be ascertained; but we are enabled to present the time required in the machine for several classes of work.

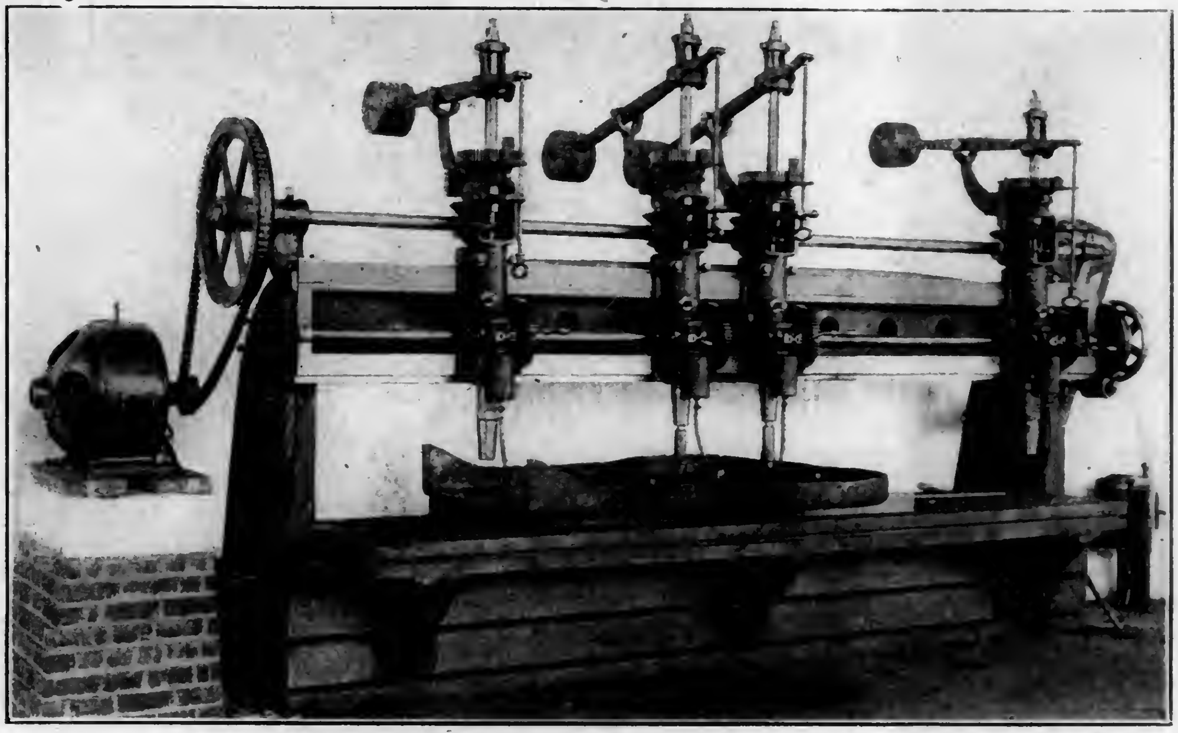


REAR VIEW OF NORTON GRINDING MACHINE, SHOWING EXTRA HEAVY CONSTRUCTION OF BED AND PARTS.



MOTOR-DRIVEN GARDNER DISC GRINDER.—CHAS. H. BESLY & CO. COLLINWOOD SHOPS.—L. S & M. S. RY.

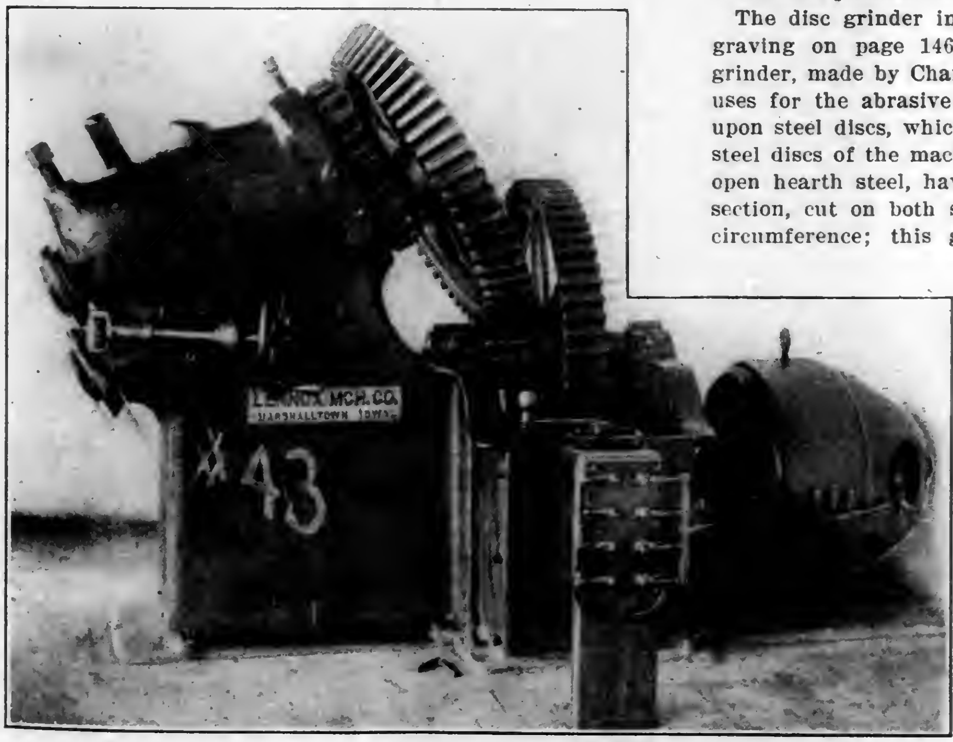
The secret of success in cylindrical grinding seems to lie in



FOUR-SPINDLE MUD RING DRILL.—NILES TOOL WORKS COMPANY. DRIVEN BY A $7\frac{1}{2}$-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

COLLINWOOD SHOPS.—L. S. & M. S. RY.

having sufficient rigidity in the frame of the machine in order to maintain the wheel axis and the work axis in exact relation to each other, and also in having the table movement so gauged that the work will traverse a distance equal to the full width of the grinding wheel during every revolution of the work spindle. These conditions not only produce absolute ac-



ROTARY BEVEL SHEAR, FOR $\frac{3}{4}$-IN. STEEL PLATE.—LENOX MACHINE COMPANY. DRIVEN BY A 10-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

COLLINWOOD SHOPS.—L. S. & M. S. RY.

curacy of cylindrical surface, but also enable stock to be removed rapidly. For producing a finer finish upon work it is, of course, only necessary to reduce the traverse speed of the table.

The disc grinding machine has demonstrated absolutely that the method of draw-filing and hand-polishing is a very expensive method of finishing flat surfaces off smooth. The disc grinder method of finishing enables flat-surface polishing to be done very accurately on a large variety of work at a very slight expense, inasmuch as an experienced operator is not required for it, and will permit complete finishing to be done in a great many cases where it would previously have been considered prohibitive by the cost of old methods.

The disc grinder in use at the Collinwood shops (see engraving on page 146) is the Gardner "spiral-groove" disc grinder, made by Charles H. Besly & Co., Chicago, Ill., which uses for the abrasive agent emery paper, or cloth, mounted upon steel discs, which revolve at a high rate of speed. The steel discs of the machine, which are of the highest grade of open hearth steel, have spiral grooves, rectangular in cross-section, cut on both sides, running from the centers to the circumference; this grooving not only serves to hold the emery paper, or cloth, more securely to the face of the disc, but also produces a slightly corrugated surface, which has been proven to cut much faster on flat-surface work than is possible with a smooth steel disc.

This machine is, of course, adapted for use with the plain emery paper, or cloth, mounted upon the discs, but far greater capacity and effectiveness may be obtained by using instead the specially prepared spiral circles which are made by C. H. Besly & Co. purposely for use with this machine. These circles consist of cloth discs coated with the abrasive laid in a spiral trace beginning at the center and ending at the circumference. The abrasive may in this way be applied in various compositions of emery, or emery and corundum, carborundum, garnet and flint, in order to be adapted to any class of work.

The combination of the spiral-circle abrasive discs and the "spiral-groove" backing discs produces a grinding combination of great effectiveness and capacity. Two-inch cold pressed hexagon nuts are ground on all eight sides to a perfect finish in

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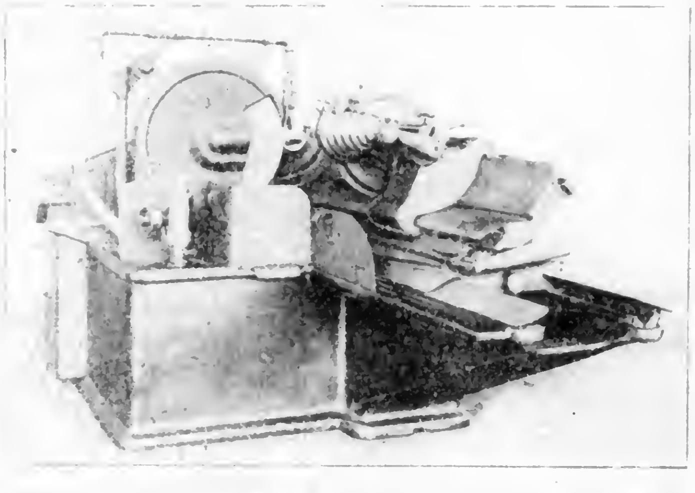

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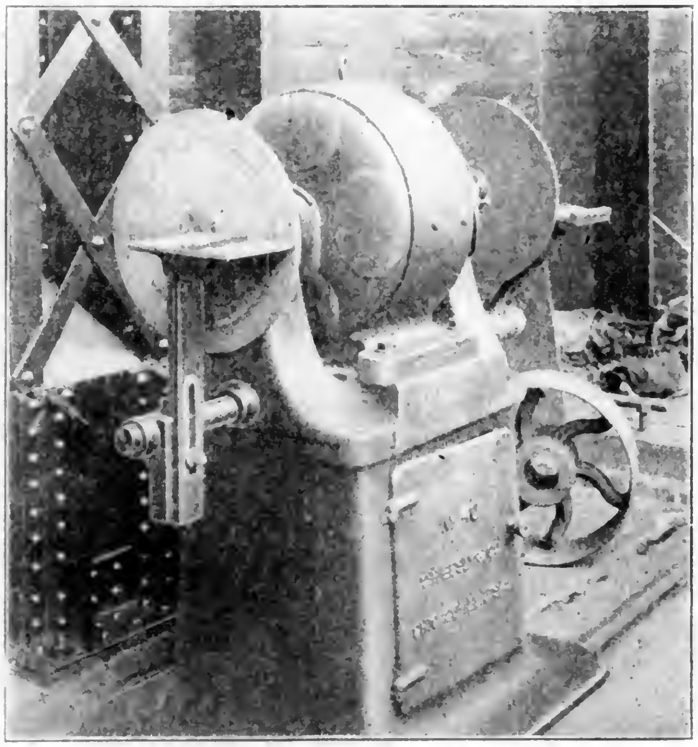

MOTOR-DRIVEN GARDNER DISC GRINDER.—CHAS. H. BESLY & CO. COLLINWOOD SHOPS.—L. S. & M. S. RY.

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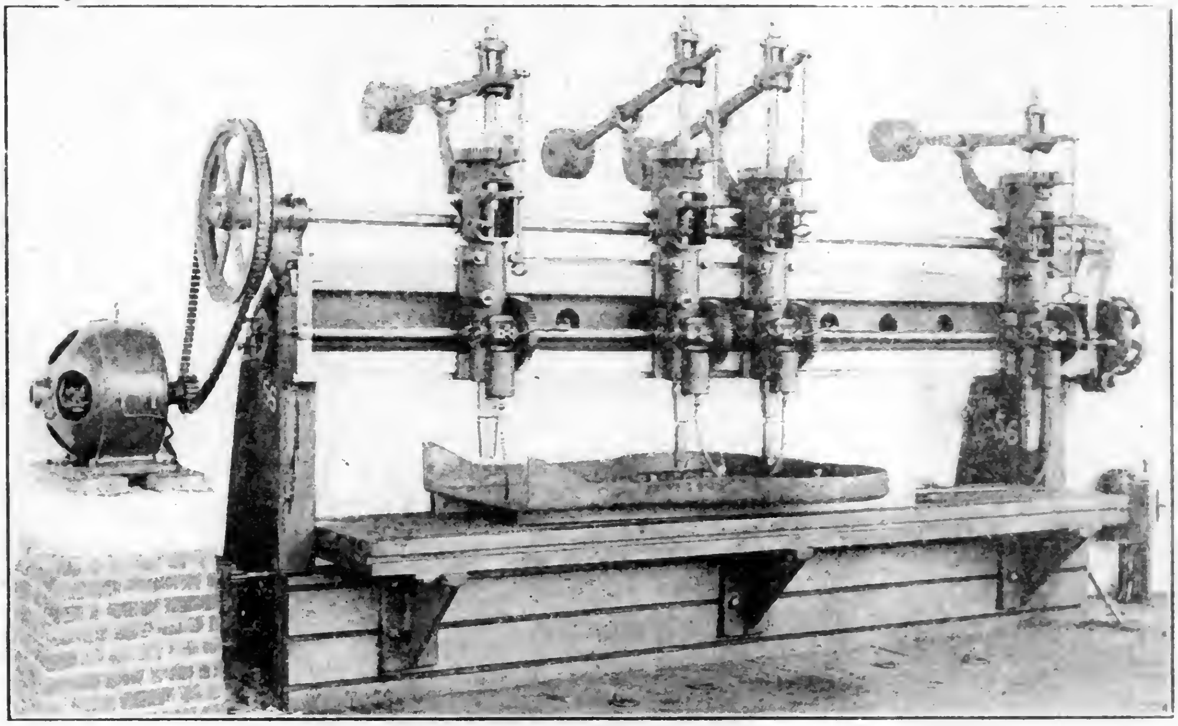

FOUR-SPINDLE MUD RING DRILL.—NILES TOOL WORKS COMPANY. DRIVEN BY A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

COLLINWOOD SHOPS.—L. S. & M. S. RY.

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ROTARY BEVEL SHEAR FOR ¾-IN. STEEL PLATE.—LENOX MACHINE COMPANY. DRIVEN BY A 10-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

COLLINWOOD SHOPS.—L. S. & M. S. RY.

The disc grinding machine has demonstrated **absolutely** that the method of draw-filing and hand-polishing is a very expensive method of finishing flat surfaces off smooth. The disc grinder method of finishing enables flat-surface polishing to be done very accurately on a large variety of work at a very slight expense, inasmuch as an experienced operator is not required for it, and will permit complete finishing to be done in a great many cases where it would previously have been considered prohibitive by the cost of old methods.

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The combination of the spiral-circle abrasive discs and the "spiral-groove" backing discs produces a grinding combination of great effectiveness and capacity. Two-inch cold pressed hexagon nuts are ground on all eight sides to a perfect finish in

one and a half minutes on this machine—less than one-tenth of the time required by previous processes. An 8 in. steel connecting-rod taper key is finished on all four sides in eight minutes, removing about 1-100 in. of stock. This machine is working perfectly and is giving the best of satisfaction.

The Gardner grinder is direct driven by a 5 h. p. constant-speed Crocker-Wheeler motor, as shown in the illustration. The controlling apparatus for the motor is located within the pedestal base of the machine, so that when the door is closed it is perfectly protected.

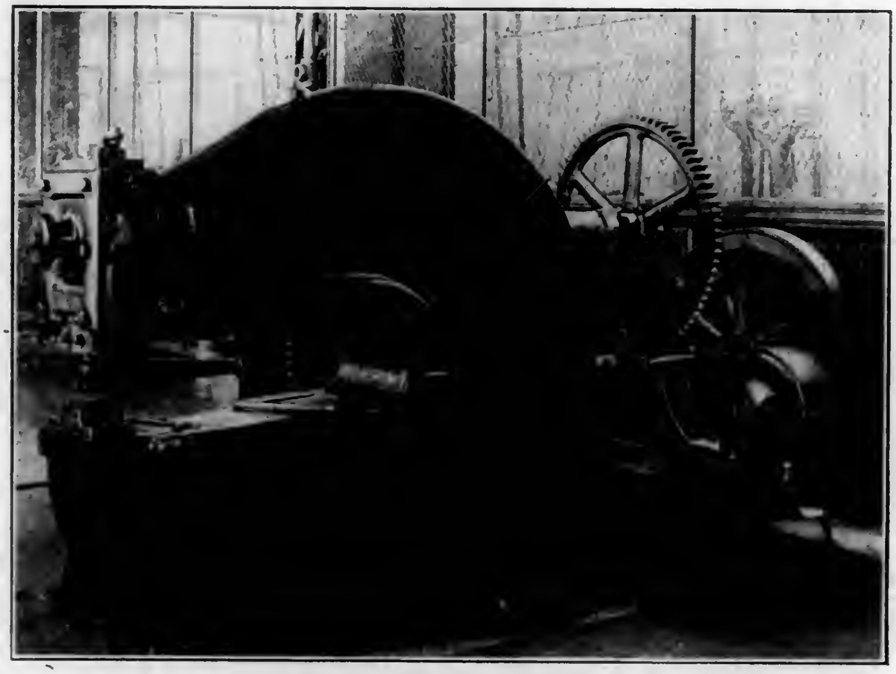
MOTOR-DRIVEN TOOLS IN THE BOILER SHOP.

The machine illustrated on page 147, the four-spindle Niles mud ring drill (tool No. 56), presents an interesting motor drive. The motor, a 7½-h.p. multiple-voltage Crocker-Wheeler motor, is mounted upon a stone-capped masonry pedestal at the end of the tool, and is connected to the shaft by a Reynold silent chain. Each of the spindles of this tool has an independent drive and independent feed clutches, and may be adjusted along the cross-rail by a rack and pinion.

The rotary bevel shear (tool No. 43), illustrated on page 147, besides presenting an interesting example of motor driving, is worthy of note as a metal-working machine. It is the No. 2 bevel shear, made by the Lennox Machine Company, Marshalltown, Iowa (Jos. T. Ryerson & Son, Chicago, agents), and is direct-driven by a 10-h.p. multiple-voltage Crocker-Wheeler motor. It has a capacity for beveling steel plate up to and including ¾ in. in thickness, and will bevel plates (at an angle of about 60 deg.) at a speed of from 400 to 500 ft. per hour, depending upon the speed at which it is driven. There is no danger of breakage or injury to the rotary blades, as the knives will not receive the plate when it is too thick.

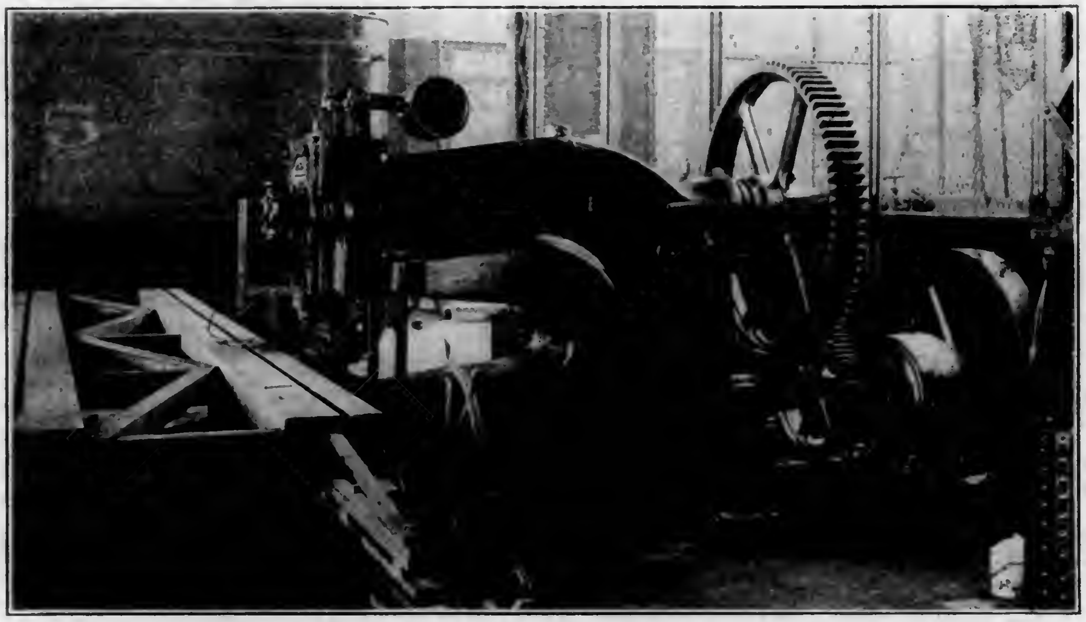
This machine will bevel the outside of flanged heads or any irregular shaped edges of plate, running either inward or outward. It will bevel the flange of dome sheets before or after being rolled or flanged, and in fact may be worked on any curved edge whatever. This machine proved itself capable, by work at the Oelwein shops of the Chicago Great Western Railway, of beveling firebox side sheets in 14 minutes that had previously taken 10 hours by hand, flue sheets in 11 minutes, as against 9½ hours by hand, etc.

Below is illustrated one of the number of Long & Allstater punches that have been installed in the boiler shop. This machine (tool No. 28) is the No. 4 single punch made by the Long & Allstater Company, Hamilton, Ohio, and is direct-driven by a 3-h.p. constant-speed Crocker-Wheeler motor mounted on a bracket at the side. The usual fly-wheel is used upon the drive in order to protect the motor from the shock resulting from the punching operation.



36-IN. THROAT NO. 4 SINGLE PUNCH.—LONG & ALLSTATER COMPANY. DRIVEN BY A 3-H.P. CONSTANT-SPEED C.-W. MOTOR.

This machine has a capacity of punching up to and including ¾-in. holes and has a 36-in. throat. Besides this tool, several single and double punches and shears made by the Long & Allstater Company are in use in the boiler shop.



36-IN. THROAT MULTIPLE PUNCH, WITH SPACING TABLE.—CLEVELAND PUNCH AND SHEAR WORKS COMPANY. DRIVEN BY A 7½-H.P. CONSTANT-SPEED C.-W. MOTOR.

At the left is illustrated the 36-in.-throat multiple punch with spacing table (tool No. 57), made by the Cleveland Punch and Shear Works Company, Cleveland, Ohio. This machine is direct-driven through a fly-wheel drive by a 7½-h.p. constant-speed Crocker-Wheeler motor, the motor being compound-wound as best adapted for this class of work. The motor is in this case mounted upon a small bracket at the side of the machine's bed. The spacing table used with this machine is operated by hand, being entirely independent of the drive. The machine, as shown in this view, is fitted up with a multiple-die block and punch holder, so that six holes are punched in the edge of the sheet at every stroke.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

REPORT BY PROF. W. F. M. GOSS.

XV.

SECTION VI. DIAGRAMS.

(*Continued from page 83.*)

The following diagrams are presented in response to a request for a presentation of the results in the form of diagrams. They reveal at a glance the effects of the changes in conditions and furnish a measure of relative values.

All of the curves are plotted in terms of draft, in inches of water, and the stack diameters. Four different heights of stack were used and there are four series of curves for each height of nozzle. As seven heights of nozzle were employed there are 28 diagrams for each form of stack. Each group of four figures represents all diameters of stacks for a given nozzle. The diagrams numbered 33 to 60, inclusive, represent straight stacks and 61 to 88, inclusive, represent taper stacks.

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 1 EXHAUST—TIP 10 INS. BELOW CENTER.

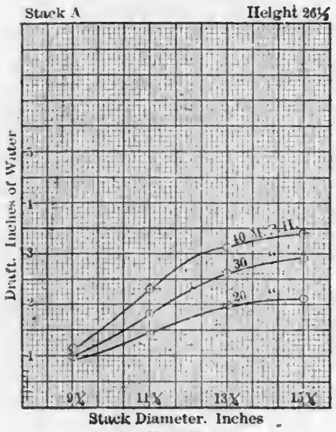


Fig. 33

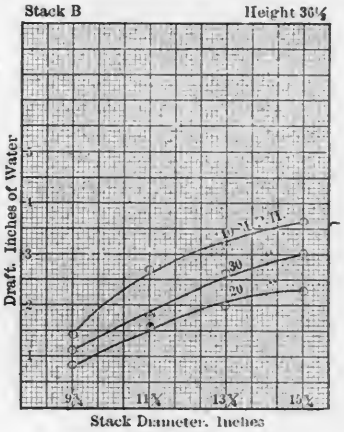


Fig. 34

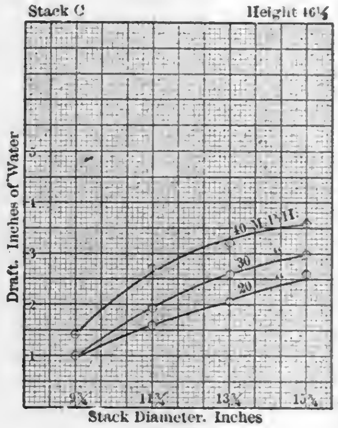


Fig. 35

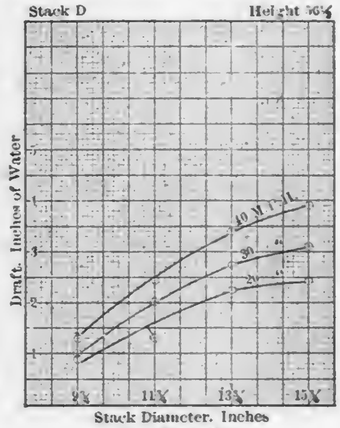


Fig. 36

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 2 EXHAUST—TIP 5 INS. BELOW CENTER.

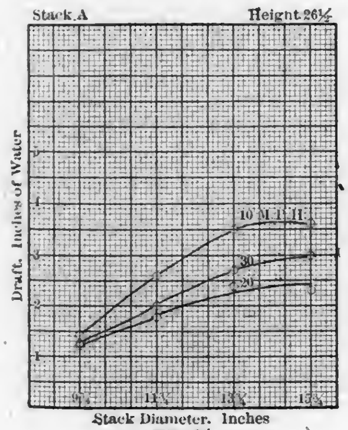


Fig. 37

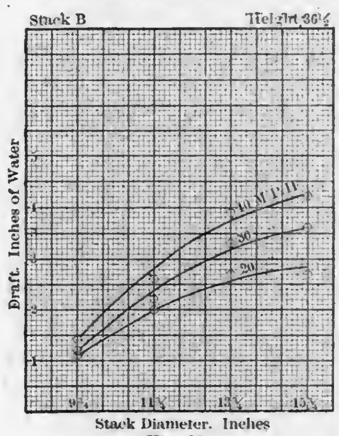


Fig. 38

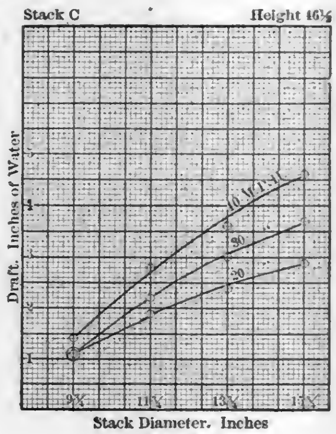


Fig. 39

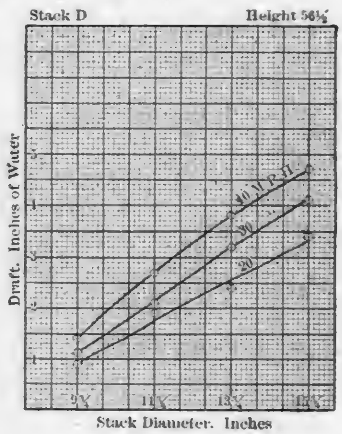


Fig. 40

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 3 EXHAUST—TIP ON CENTER.

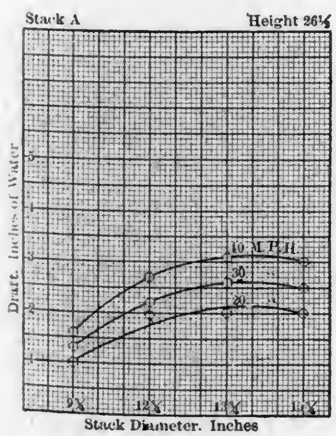


Fig. 41.

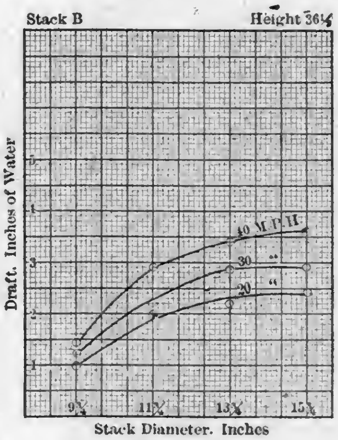


Fig. 42

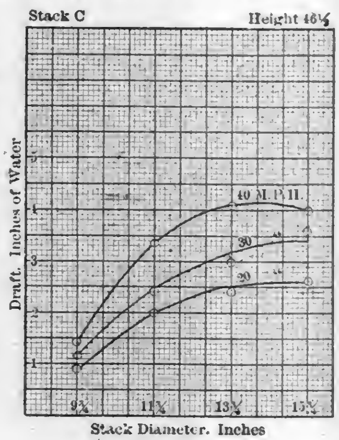


Fig. 43

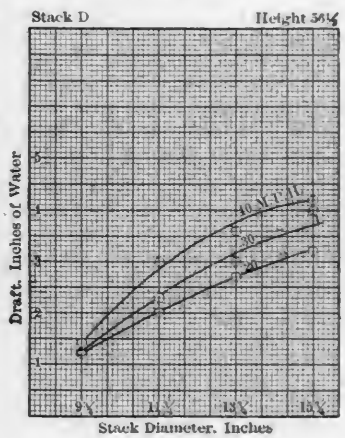
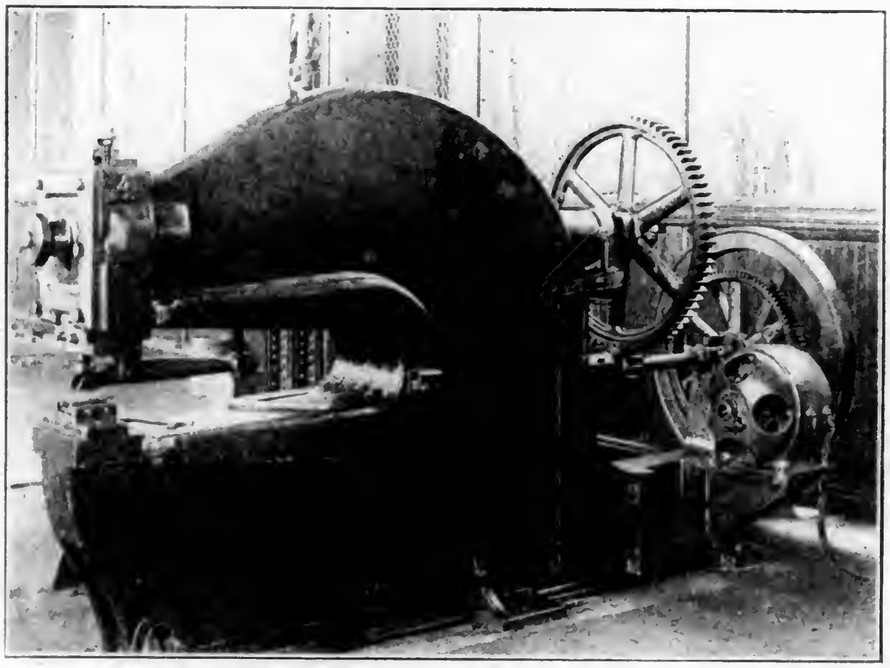


Fig. 44

one and a half minutes on this machine—less than one-tenth of the time required by previous processes. An 8 in. steel connecting-rod taper key is finished on all four sides in eight minutes, removing about 1-100 in. of stock. This machine is working perfectly and is giving the best of satisfaction.

The Gardner grinder is direct driven by a 5 h. p. constant-speed Crocker-Wheeler motor, as shown in the illustration.

The controlling apparatus for the motor is located within the pedestal base of the machine, so that when the door is closed it is perfectly protected.

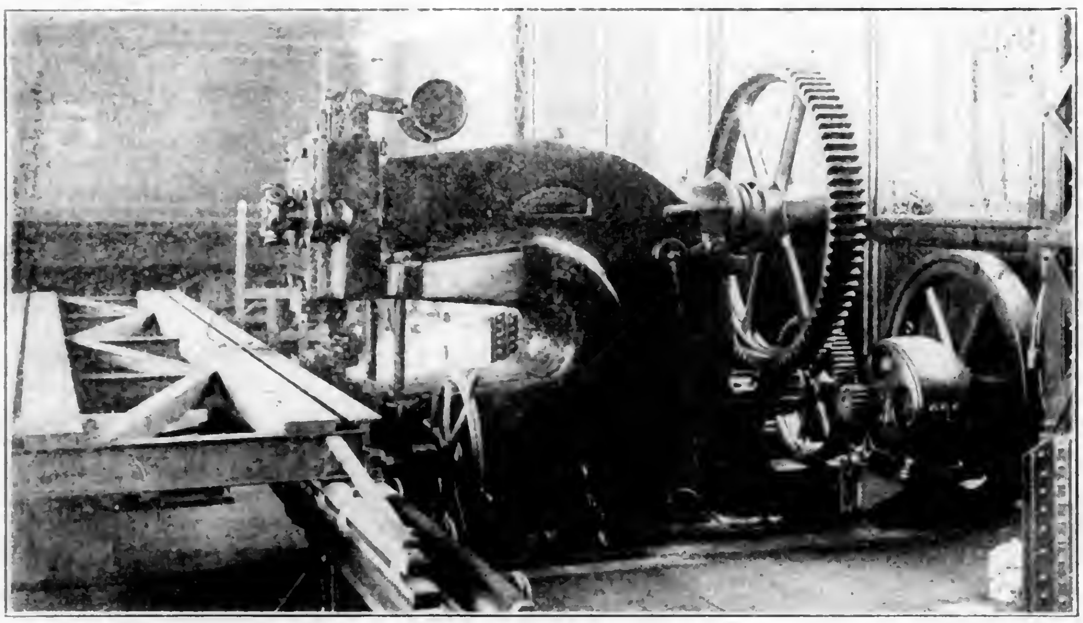


36-IN. THROAT NO. 4 SINGLE PUNCH.—LONG & ALLSTATER COMPANY. DRIVEN BY A 3-H.P. CONSTANT-SPEED C.-W. MOTOR.

MOTOR DRIVEN TOOLS IN THE BOILER SHOP.

The machine illustrated on page 147, the four-spindle Niles mud ring drill (tool No. 56), presents an interesting motor drive. The motor, a $7\frac{1}{2}$ h.p. multiple-voltage Crocker-Wheeler motor, is mounted upon a stone-capped masonry pedestal at the end of the tool, and is connected to the shaft by a Reynold silent chain. Each of the spindles of this tool has an independent drive and independent feed clutches, and may be adjusted along the cross-rail by a rack and pinion.

The rotary bevel shear (tool No. 43), illustrated on page 147, besides presenting an interesting example of motor driving, is worthy of note as a metal-working machine. It is the No. 2 bevel shear, made by the Lennox Machine Company, Marshalltown, Iowa (Jos. T. Ryerson & Son, Chicago, agents), and is direct-driven by a 10-h.p. multiple-voltage Crocker-Wheeler motor. It has a capacity for beveling steel plate up to and including $\frac{3}{4}$ in. in thickness, and will bevel plates (at an angle of about 60 deg.) at a speed of from 100 to 500 ft. per hour, depending upon the speed at which it is driven. There is no danger of breakage or injury to the rotary blades, as the knives will not receive the plate when it is too thick.



36-IN. THROAT MULTIPLE PUNCH, WITH SPACING TABLE.—CLEVELAND PUNCH AND SHEAR WORKS COMPANY. DRIVEN BY A $7\frac{1}{2}$-H.P. CONSTANT-SPEED C.-W. MOTOR.

This machine will bevel the outside of flanged heads or any irregular shaped edges of plate, running either inward or outward. It will bevel the flange of dome sheets before or after being rolled or flanged, and in fact may be worked on any curved edge whatever. This machine proved itself capable, by work at the Oelwein shops of the Chicago Great Western Railway, of beveling firebox side sheets in 14 minutes that had previously taken 10 hours by hand, flue sheets in 11 minutes, as against $9\frac{1}{2}$ hours by hand, etc.

Below is illustrated one of the number of Long & Allstater punches that have been installed in the boiler shop. This machine (tool No. 28) is the No. 4 single punch made by the Long & Allstater Company, Hamilton, Ohio, and is direct-driven by a 3-h.p. constant-speed Crocker-Wheeler motor mounted on a bracket at the side. The usual fly-wheel is used upon the drive in order to protect the motor from the shock resulting from the punching operation.

This machine has a capacity of punching up to and including $\frac{3}{4}$-in. holes and has a 36-in. throat. Besides this tool, several single and double punches and shears made by the Long & Allstater Company are in use in the boiler shop.

At the left is illustrated the 36-in.-throat multiple punch with spacing table (tool No. 57), made by the Cleveland Punch and Shear Works Company, Cleveland, Ohio. This machine is direct-driven through a fly-wheel drive by a $7\frac{1}{2}$-h.p. constant-speed Crocker-Wheeler motor, the motor being compound-wound as best adapted for this class of work. The motor is in this case mounted upon a small bracket at the side of the machine's bed. The spacing table used with this machine is operated by hand, being entirely independent of the drive. The machine, as shown in this view, is fitted up with a multiple-die block and punch holder, so that six holes are punched in the edge of the sheet at every stroke.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

Report by Prof. W. F. M. Goss.

XV.

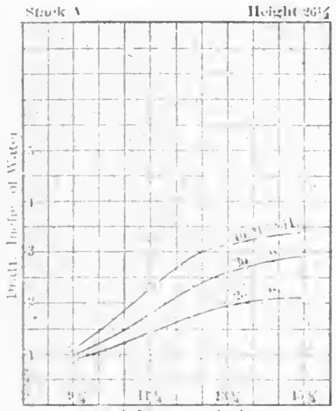
Section VI. Diagrams.

(*Continued from page 83.*)

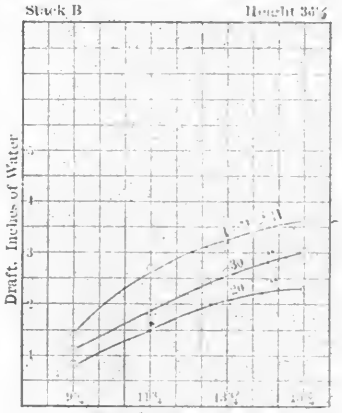
The following diagrams are presented in response to a request for a presentation of the results in the form of diagrams. They reveal at a glance the effects of the changes in conditions and furnish a measure of relative values.

All of the curves are plotted in terms of draft, in inches of water, and the stack diameters. Four different heights of stack were used and there are four series of curves for each height of nozzle. As seven heights of nozzle were employed there are 28 diagrams for each form of stack. Each group of four figures represents all diameters of stacks for a given nozzle. The diagrams numbered 33 to 60, inclusive, represent straight stacks and 61 to 88, inclusive, represent taper stacks.

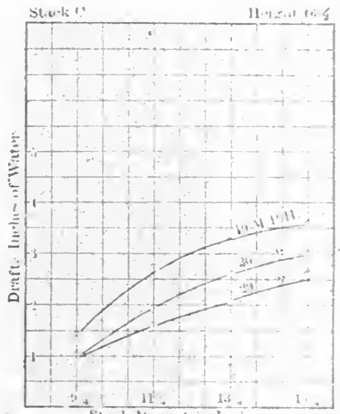
STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 1 EXHAUST—TIP 10 INS. BELOW CENTER.



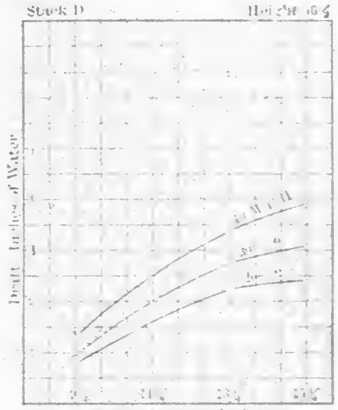
Stack Diameter, Inches
Fig. 33



Stack Diameter, Inches
Fig. 34

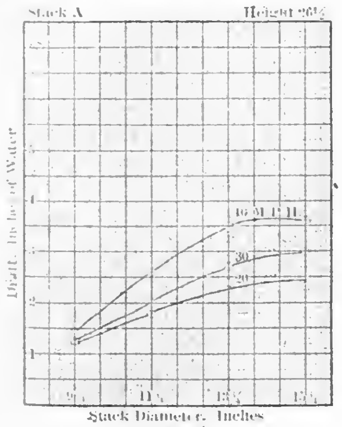


Stack Diameter, Inches
Fig. 35

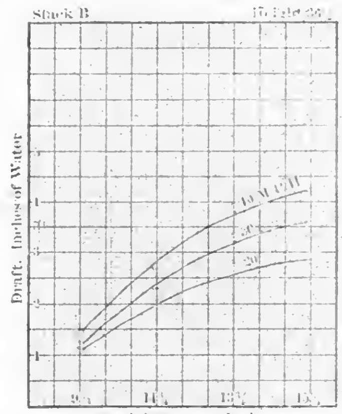


Stack Diameter, Inches
Fig. 36

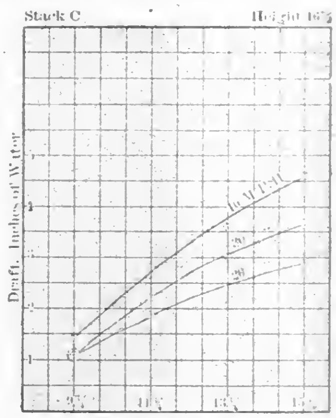
STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 2 EXHAUST—TIP 5 INS. BELOW CENTER.



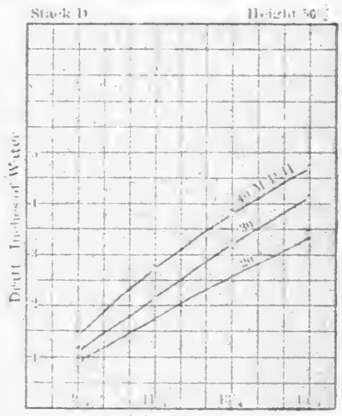
Stack Diameter, Inches
Fig. 37



Stack Diameter, Inches
Fig. 38

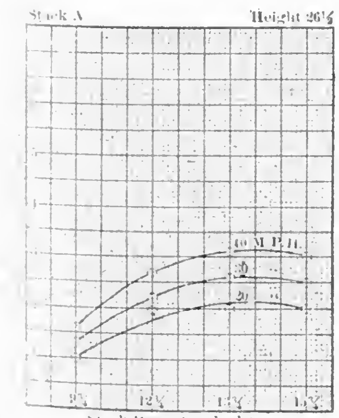


Stack Diameter, Inches
Fig. 39

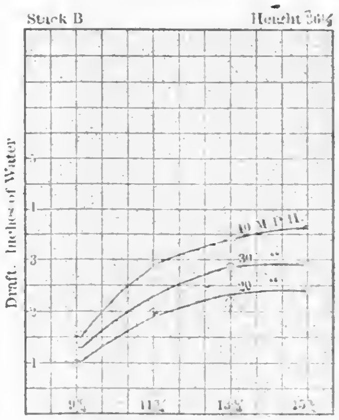


Stack Diameter, Inches
Fig. 40

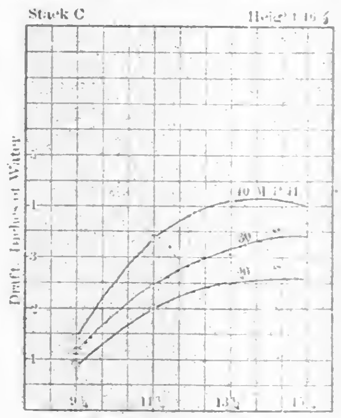
STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 3 EXHAUST—TIP ON CENTER.



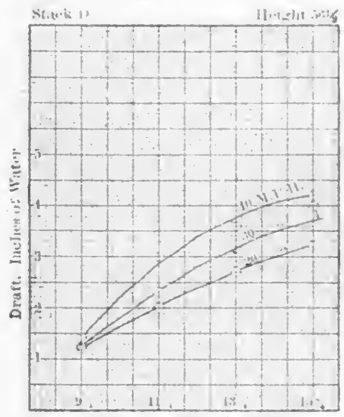
Stack Diameter, Inches
Fig. 41



Stack Diameter, Inches
Fig. 42



Stack Diameter, Inches
Fig. 43



Stack Diameter, Inches
Fig. 44

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 4 EXHAUST—TIP 5 INS. ABOVE CENTER.

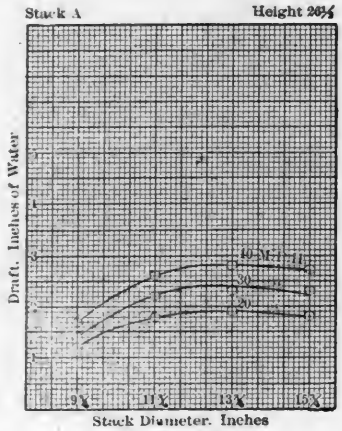


Fig. 45

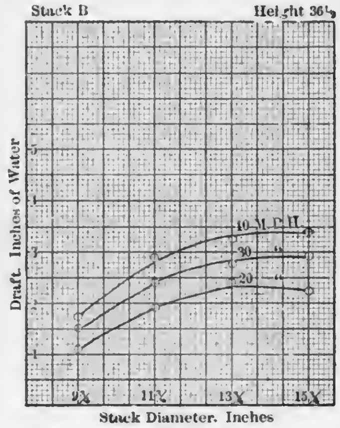


Fig. 46

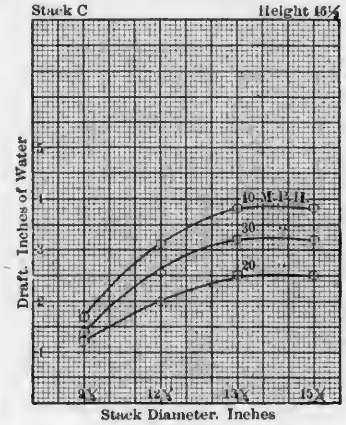


Fig. 47

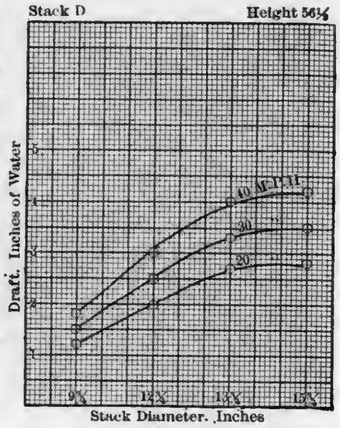


Fig. 48

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 5 EXHAUST—TIP 10 INS. ABOVE CENTER.

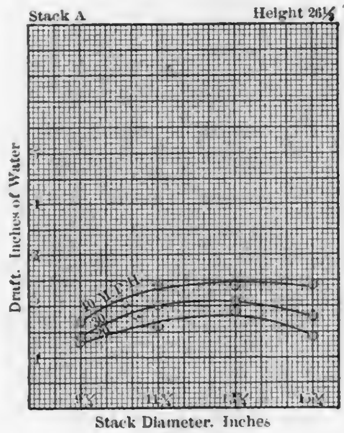


Fig. 49

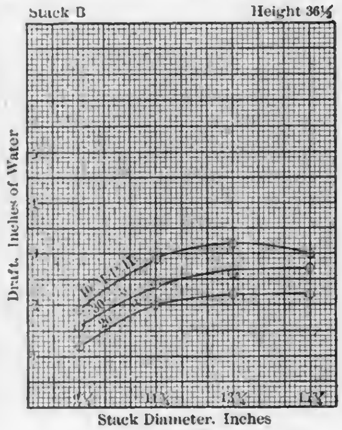


Fig. 50

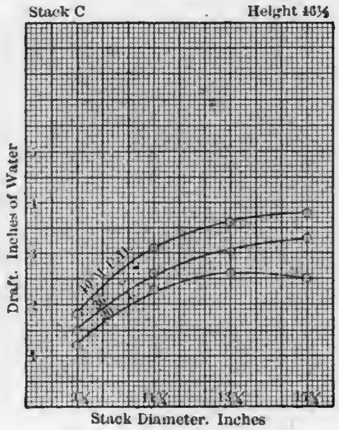


Fig. 51

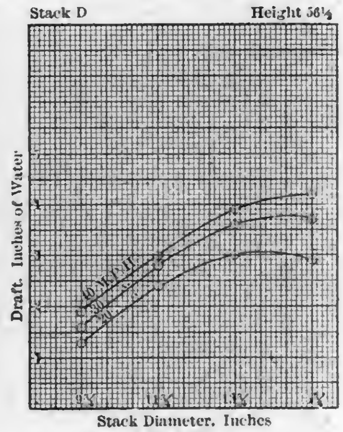


Fig. 52

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 6 EXHAUST—TIP 15 INS. ABOVE CENTER.

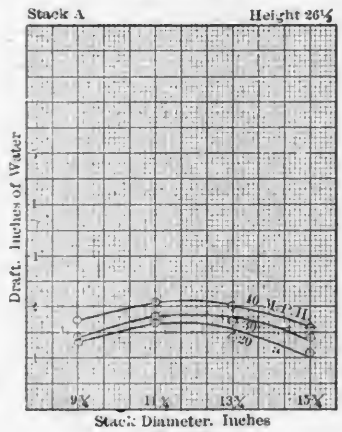


Fig. 53

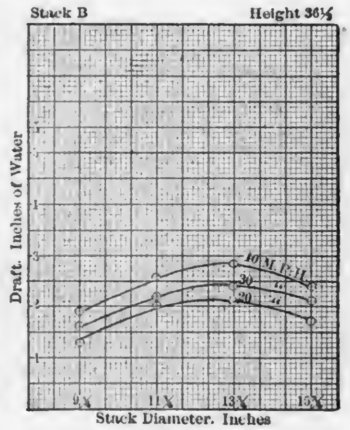


Fig. 54

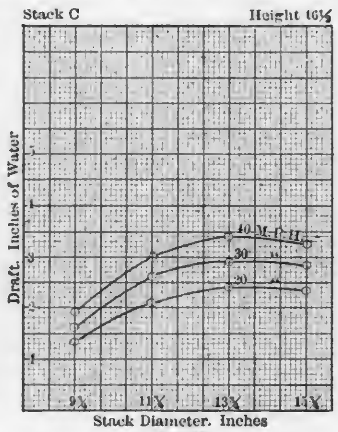


Fig. 55

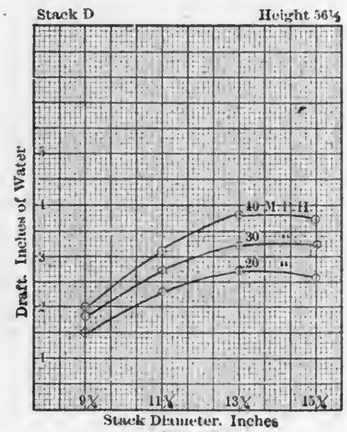


Fig. 56

STRAIGHT STACKS IN COMBINATION WITH NOZZLE NO. 7 EXHAUST—TIP 20 INS. ABOVE CENTER.

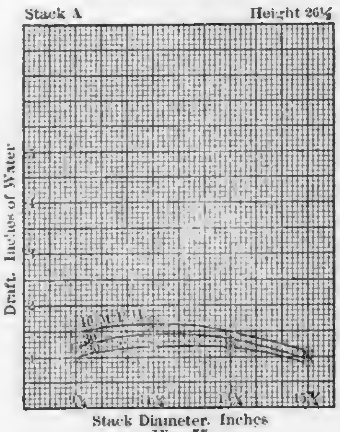


Fig. 57

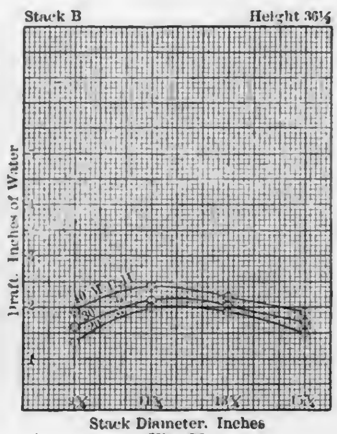


Fig. 58

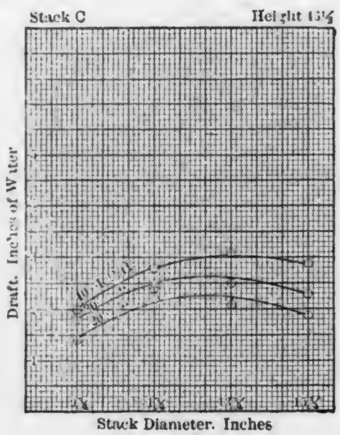


Fig. 59

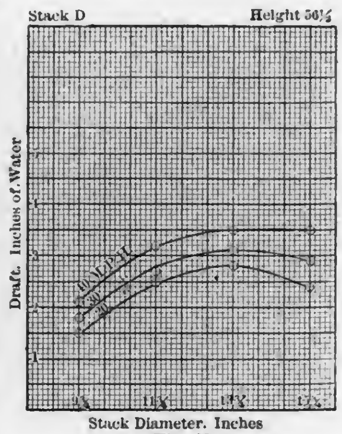


Fig. 60

TAPER STACKS IN COMBINATION WITH NOZZLE NO. 1 EXHAUST—TIP 10 INS. BELOW CENTER.

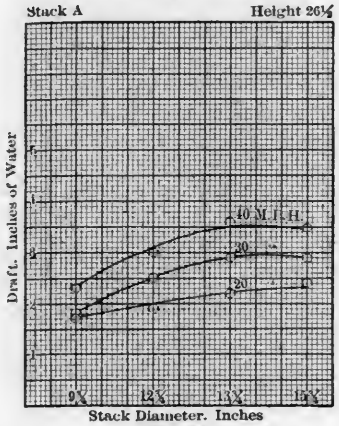


Fig. 61

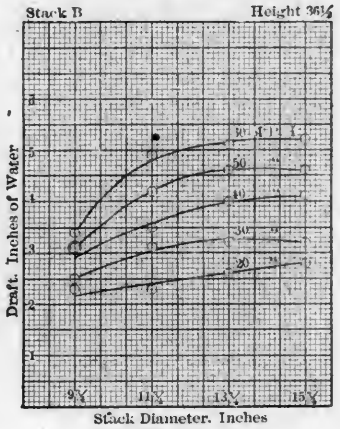


Fig. 62

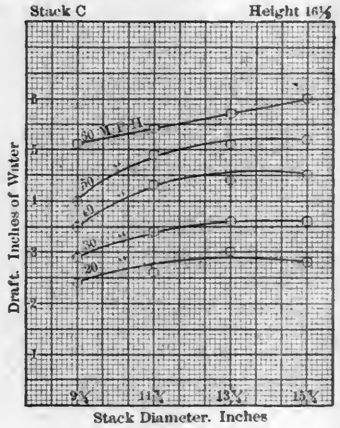


Fig. 63

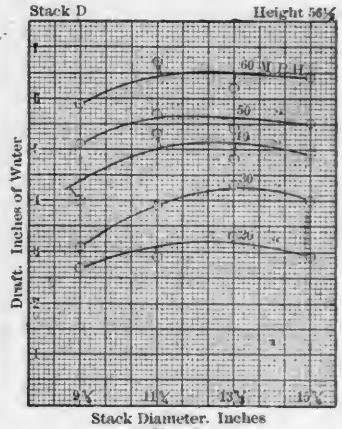


Fig. 64

TAPER STACKS IN COMBINATION WITH NOZZLE NO. 2 EXHAUST—TIP 5 INS. BELOW CENTER.

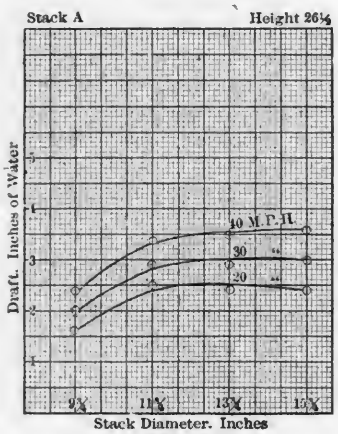


Fig. 65

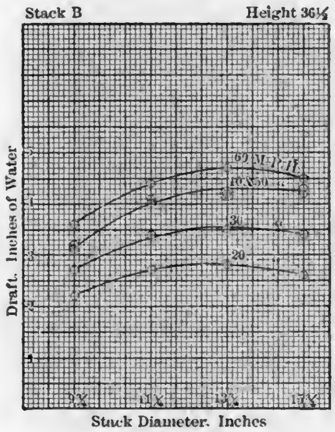


Fig. 66

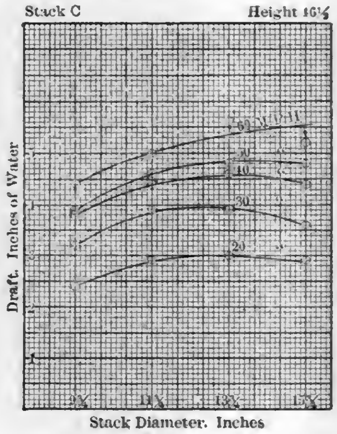


Fig. 67

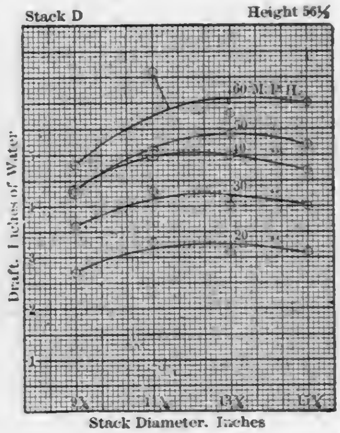


Fig. 68

TAPER STACKS IN COMBINATION WITH NOZZLE NO. 3 EXHAUST—TIP ON CENTER.

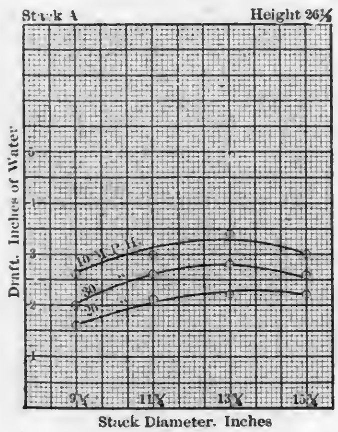


Fig. 69

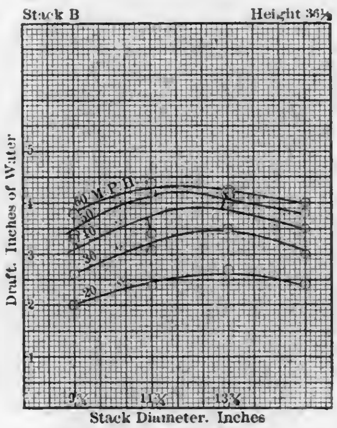


Fig. 70

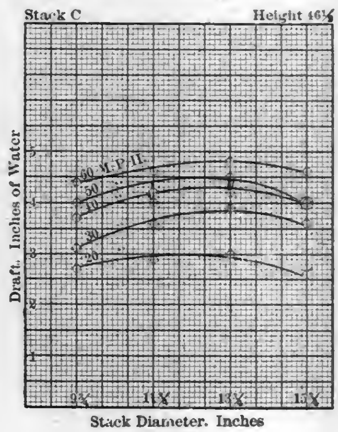


Fig. 71

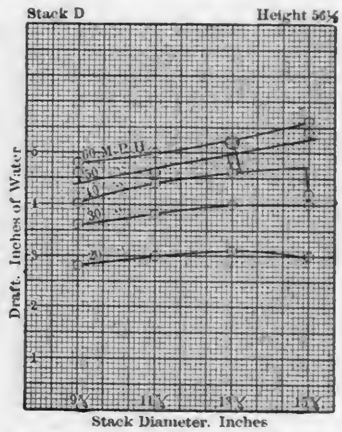


Fig. 72

TAPER STACKS IN COMBINATION WITH NOZZLE NO 4 EXHAUST—TIP 5 INS. ABOVE CENTER.

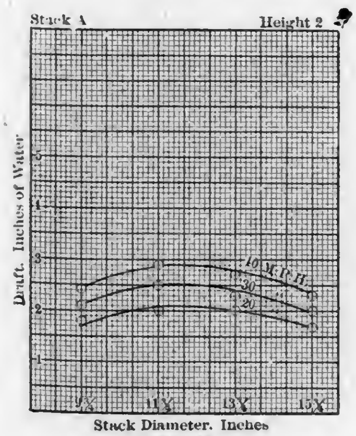


Fig. 73

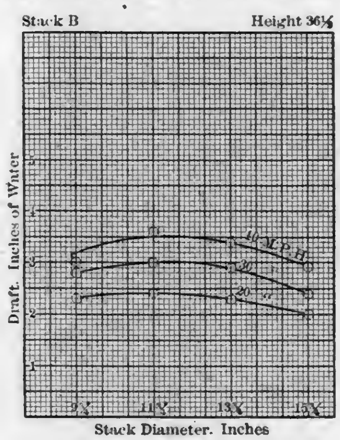


Fig. 74

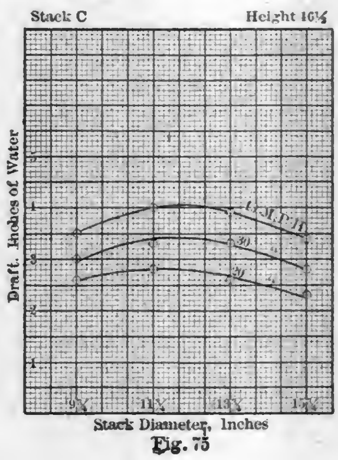


Fig. 75

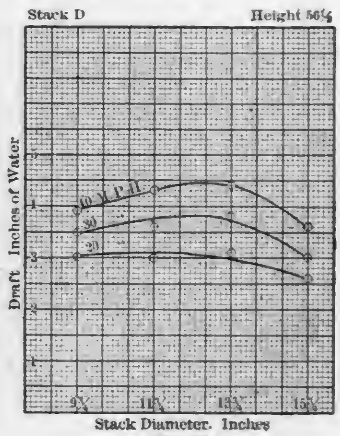


Fig. 76

TAPER STACKS IN COMBINATION WITH NOZZLE NO. 5 EXHAUST—TIP 10 INS. ABOVE CENTER.

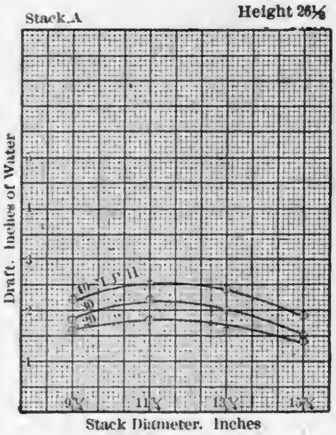


Fig. 77

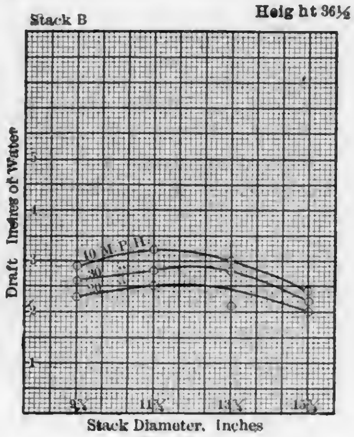


Fig. 78

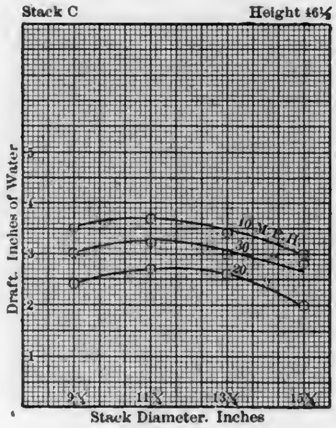


Fig. 79

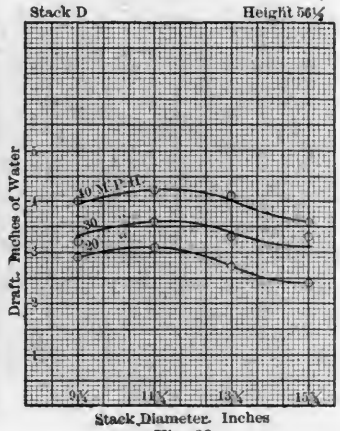


Fig. 80

TAPER STACKS IN COMBINATION WITH NOZZLE NO. 6 EXHAUST—TIP 15 INS. ABOVE CENTER.

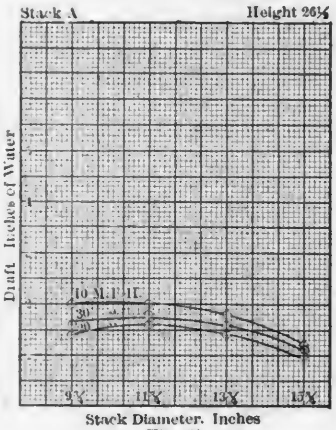


Fig. 81

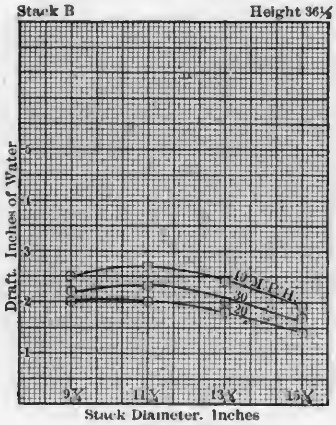


Fig. 82

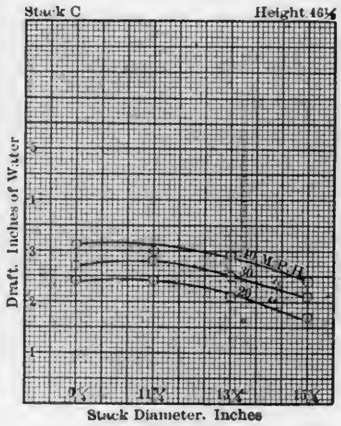


Fig. 83

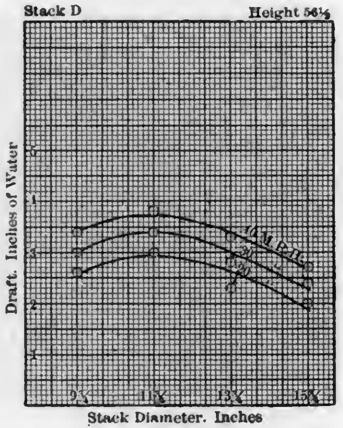


Fig. 84

TAPER STACKS IN COMBINATION WITH NOZZLE NO. 7 EXHAUST—TIP 20 INS. ABOVE CENTER.

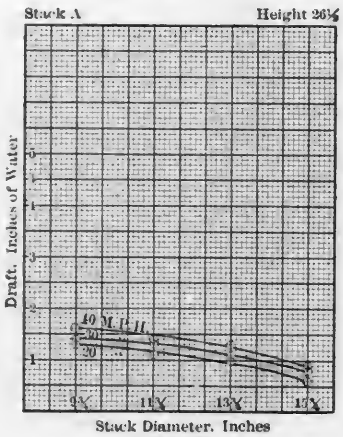


Fig. 85

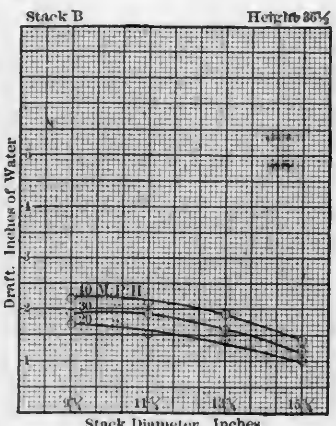


Fig. 86

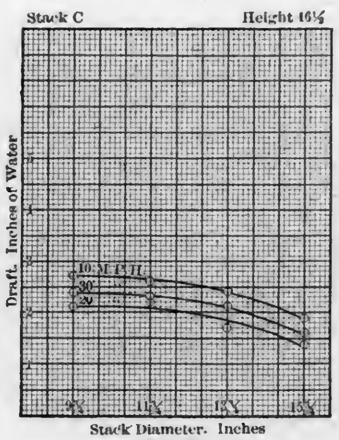


Fig. 87

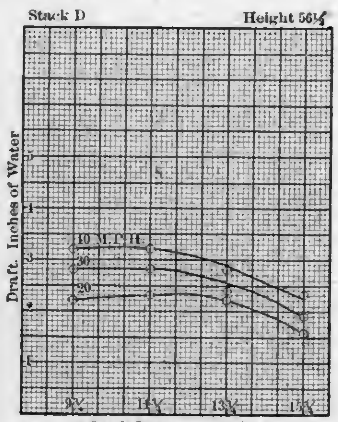


Fig. 88

SECTION VI.—ARTICLE 37 *(Continued).*

The relation between draft and stack diameter for stacks at different heights, as disclosed by a series of tests at different cut-offs, is shown by Figs. 89 to 91, inclusive. The three figures referred to give the results obtained in connection with exhaust nozzle No. 1. Tables XI., XII. and XIII. contain numerical values not only for this nozzle but for a series in connection with nozzles Nos. 2 and 3.

As a matter of interest in checking curves, it may be noted that in this series and in the preceding series there are certain curves which are common to both, namely, those of the previous series representing the tapered stacks, nozzle No. 1, and a speed of 40 miles an hour; and those of the present series for which the cut-off is 6.4 ins. Thus, compare the 40-mile curves, Figs. 62, 63 and 64, with the 6.4 curve of Figs. 89, 90 and 91, respectively. Such a comparison will disclose a fair degree of consistency in the location of the experimental inclusive. If curves for different speeds show maximum draft to have been obtained with different diameters of stacks, then it will appear that a stack diameter best suited for one speed is not the best for some other speed, while on the other hand, if the curves of each figure representing different speeds are similar in form, they sustain the general conclusion. A review of the several figures will show that the curves are quite similar. Thus in Fig. 45 the curve for a speed of 20 miles an hour represents the variation in draft resulting from changes in the diameter of the stack. In the same figure the curve for 40 miles an hour, covering the same changes in diameter of stack, while representing different values, nevertheless discloses precisely the same relationships. For 20 miles and 40 miles a diameter of stack of 13¾ ins. gives the highest draft. A review of all the figures, while disclosing discrepancies in individual points, will show a practical agreement in this respect. The same thing is true of curves representing different

RESULTS OBTAINED BY VARYING CUT-OFF—TAPER STACKS.

SPEED CONSTANT—40 M. P. H. NOZZLE NO. 1—EXHAUST TIP 10 INS. BELOW CENTER.

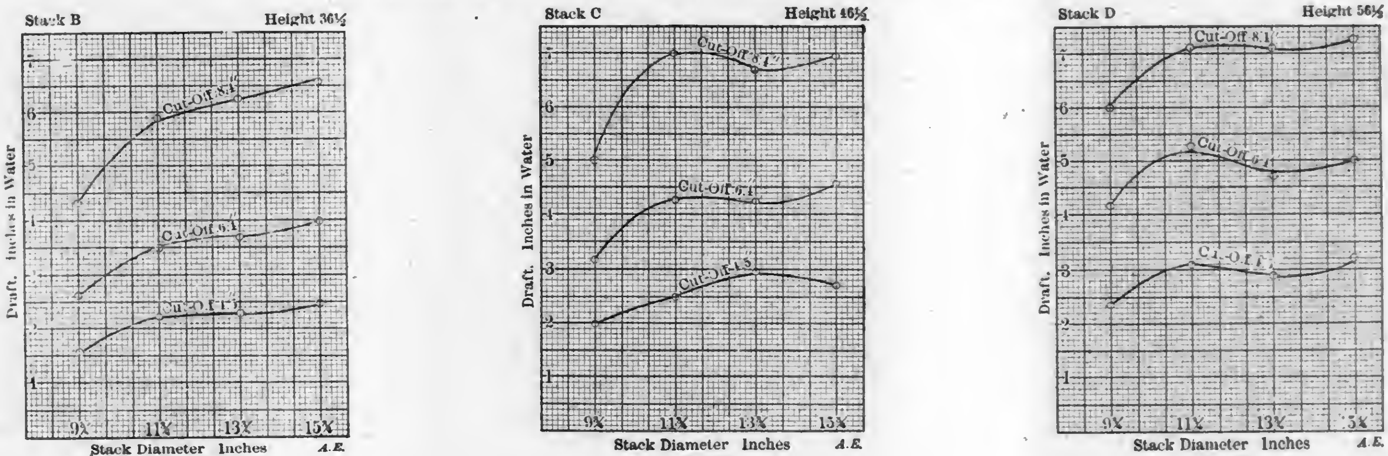


Fig. 89 Fig. 90 Fig. 91

points, but in some cases there is a difference in the form of the curve which has been employed. In applying a curve to points which fall irregularly, the judgment of the experimenter has been influenced by the form of related curves, some of which accurately represent the points they connect. There are a few instances in which the tendency of related curves seems not to be the same in the two series, and it is for this reason that a given curve in the cut-off series does not exactly check with its corresponding curve in the variable speed series. Nevertheless, it should be noted that variations in the numerical value of the draft represented by such variations are relatively small. A study of all curves obtained in the variable cut-off series, a portion only of which are herewith presented, shows them to be less satisfactory than those obtained in the more elaborate series representing the work at constant speed.

38. *The Effect on Stack Proportions of Changes in Speed and Cut-Off.*—The experiments were made to involve a great variety of conditions with reference to speed and cut-off, in order that the changes in the efficiency of the stack arrangement, which might result from such changes, might be known. With the large array of data now at hand, it can be stated with confidence that, within reasonable limits, no change in the condition of running effects in any marked degree the efficiency of the stack; that a stack and nozzle which is satisfactory at one speed will be found satisfactory for all speeds, and if satisfactory under one condition of cut-off, it will be found reasonably satisfactory under all conditions of cut-off. This conclusion is important since, if it is true, it will operate to greatly simplify future experiments involving the front-end arrangement. We should, therefore, examine with care the evidence upon which the statement is based.

The effect upon the draft of changes in speed is shown by comparing the several curves in each of the figures, 33 to 88, speeds, all for a given series being approximately similar. The curves for different cut-offs, a few only of which are herewith presented, show the same condition to prevail, though, as previously noted, there is not the same harmony in these points as in those previously discussed. In some cases the individual points appear to differ widely from the mean of other points with which they should be compared. In many cases where this has been found true an attempt has been made to correct by repeating the tests, with the result that the values first obtained have been secured. In other words, the data as given represents the conditions which prevail, and the fact that the points refused to fall into line upon any ample curve can not be satisfactorily explained. It is evident that under certain specific conditions, nodes or eddies form in the issuing stream which greatly affect the efficiency of the jet.

Since, now, it may be said that the dimensions of the stack are not dependent upon the conditions of running, it will be of interest to add that such conclusion, based on the results obtained in the present series of experiments, confirms a conclusion drawn from certain tests made some years ago to determine the action of the exhaust jet, an account of which forms a part of the Proceedings of the Master Mechanics' Association for 1896. The statement which was then made and which is now reinforced by a much more elaborate array of data, was to the effect that, with a given arrangement of stack and nozzle, the draft is dependent upon the weight of steam exhausted in a unit of time. The draft increases when the quantity of steam discharged per minute increases. It makes little difference whether the increase in the discharge is due to an increase of speed or to an increase of cut-off or of throttle opening. That this is true for changes of speed is made clear by Table XIV., in which is given a comparison of changes in draft values with corresponding changes in the volume of steam exhausted.

TABLE XIV.

A COMPARISON OF CHANGES IN DRAFT VALUES WITH CORRESPONDING CHANGES IN THE VOLUME OF STEAM EXHAUSTED.

Nozzle No. 3. Exhaust Tip on Center Line of Boiler.

Stacks.			Change in Speed Miles.	Ratio of Change in Draft.	Ratio of Change in Water Used Per Hour.
Height.	Diameter.	Form.			
26½	9¾	Taper	20 to 30	1.25	1.33
26½	9¾	Taper	30 to 40	1.30	1.19
36½	9¾	Taper	20 to 30	1.30	1.33
36½	9¾	Taper	30 to 40	1.23	1.19
46½	9¾	Taper	20 to 30	1.15	1.33
46½	9¾	Taper	30 to 40	1.19	1.19
56½	9¾	Taper	20 to 30	1.25	1.33
56½	9¾	Taper	30 to 40	1.14	1.19
26½	11¾	Taper	20 to 30	1.23	1.33
26½	11¾	Taper	30 to 40	1.14	1.19
36½	11¾	Taper	20 to 30	1.29	1.33
36½	11¾	Taper	30 to 40	1.13	1.19
46½	11¾	Taper	20 to 30	1.24	1.33
46½	11¾	Taper	30 to 40	1.11	1.19
56½	11¾	Taper	20 to 30	1.26	1.33
56½	11¾	Taper	30 to 40	1.15	1.19
		Average.		1.21	1.26

Following the first line of this table, it will be seen that when the speed is changed from 20 to 30 miles, the draft is increased in the ratio of from 1 to 1.25, and the steam exhausted is increased in the ratio of from 1 to 1.33, which is an approach to agreement. Similar comparisons are shown for various diameters and heights of stacks, the average of all being, for changes in draft, 1.21, and for changes in steam exhausted, 1.26, which makes the check very close. The results of such a comparison upon other figures tends to further confirm the general conclusion.

39. *A Review of Best Results.*—From an inspection of the results of all the tests, the highest draft readings have been selected for each condition of speed and cut-off. These, with the designation of stack and nozzle employed in securing them, are set down in the columns forming Table XV. Results thus chosen constitute approximately 5 per cent. of the whole number obtained, and may be accepted as representing the best results obtainable under any combination of stack and nozzle involved by the experiments.

TABLE XV.

STACK AND NOZZLE COMBINATION GIVING BEST RESULTS.

Speed M.P.H.	Cut-Off Notch.	Draft Ins. of Water.	Nozzle Number.	Stack Number.
20	5	3.4	2	7—D
20	5	3.3	1	6—D
20	5	3.3	2	4—D
20	5	3.2	3	7—D
20	5	3.1	5	4—D
20	5	3.1	2	6—D
20	5	3.1	3	6—D
20	5	3.1	4	6—D
20	5	3.1	2	8—D
30	5	4.3	2	4—D
30	5	4.3	1	6—D
30	5	4.1	2	7—D
30	5	4.0	2	6—D
30	5	4.0	3	7—D
30	5	4.0	3	7—D
30	5	4.0	1	8—D
30	5	4.0	2	8—D
30	5	4.0	3	8—D
40	5	5.2	3	6—D
40	5	5.0	2	4—D
40	5	5.0	2	6—D
40	5	4.9	1	8—D
40	5	4.8	1	6—D
40	5	4.7	2	7—D
40	5	4.7	2	8—D
40	5	4.6	2	4—C
50	5	5.5	1	8—D
50	5	5.4	1	6—D
50	5	5.4	2	6—D
50	5	5.4	3	8—D
50	5	5.3	1	4—D
60	5	6.6	2	4—D
60	5	6.4	1	8—D
60	5	6.2	1	6—D
60	5	6.1	1	4—D
60	5	6.0	2	8—D
40	3	3.6	2	8—D
40	3	3.2	1	8—D
40	3	3.1	1	4—D
40	3	3.0	3	6—D
40	3	3.0	3	8—D
40	3	3.0	1	6—C
40	5	5.3	1	4—D
40	5	5.0	1	8—D
40	5	4.8	2	8—D
40	5	4.7	1	6—D
40	5	4.6	1	8—C
40	7	7.8	1	8—D
40	7	7.6	1	4—D
40	7	7.6	1	6—D
40	7	7.6	2	8—D
40	7	7.4	2	6—D

This table shows at a glance that all the highest draft readings were obtained with the "D" stacks, which designation embraces those of greatest length employed in the experiments (56½ ins). The "C" stacks, which are 10 ins. shorter than the "D" stacks, appear in the table but three times, and in two of these instances the draft is inferior to that given by the higher stack. Stacks bearing even numbers are tapered and those bearing odd numbers are straight. It is noteworthy that practically all of the numbers appearing in the table of best results represent tapered stacks. The stack numbers which most frequently appear are 4, 6 and 8, representing a diameter at the choke of 11¾, 13¾ and 15¾ ins., respectively.

It will be of interest to note, also, that the table of best results does not contain a single result derived from the use of the normal stack of the experimental locomotive, which was supplied by the builder, neither does it contain any result obtained from the use of the inside stack, a detailed consideration of which is to be hereinafter presented.

Resorting now to a detailed study covering all the various heights and diameters of stacks experimented upon, and dealing first with the straight stacks, the large spots upon Figs. 92 to 95, inclusive, show the best diameters for each height of stack experimented upon, and for each height of nozzle employed. Thus, disregarding for the present the oblique line drawn upon these diagrams, the large spots upon Fig. 92 show the best diameter of stack for each height of nozzle employed, when the height of the stack is limited to 26½ ins.; those upon Fig. 93 show the best diameter of stack for each height of nozzle employed, when the height of the stack is limited to 36½ ins.; those upon Fig. 94 show the best diameter of stack for each height of nozzle when the height of the stack is limited to 46½ ins.; and those upon Fig. 95 show the best diameter of stack for each height of nozzle when the height of stack is limited to 56½ ins. In each case the large spots represent the diameter of the experimental stacks giving the highest draft. The points are not located from curves. Since the experimental stacks varied one from another by steps of 2 ins., the exact diameter represented by a given large spot does not necessarily represent the most desirable diameter or the conditions defined; that we will hereafter proceed to find.

Continuing to give attention to the black spots of the diagrams, it will be noticed that some of the larger spots have smaller spots connected with them by a horizontal line. In some cases, there is a small spot on one side of the larger spot, and in other cases there are smaller spots on both sides. These smaller spots indicate that the next sized stack on one or the other sides, or on both sides of the best experimental stack gave results almost as good as the best. Instead of having a series of points representing the experimental data, we have a series of lines which may be employed to establish a zone of good performance. Concerning the width of this zone, it should be noted that the lines span but half the distance between the position of the stack which was best and that which is almost as good; also, that in cases where stacks on one or the other side of the best were not almost as good, no line whatever has been drawn.

A review of the diagrams, Figs. 92 to 95, shows at a glance that the largest straight stack (15¾ ins.) while, perhaps, sufficient in diameter for the least height (Fig. 92), was quite insufficient for the lower nozzle position when the stack height was increased beyond 26½ ins. This is best shown by Fig. 95. The best results in connection with this stack were obtained for the four lowest positions of the exhaust pipe. When the tip of the exhaust pipe was 5 ins. above the center line of the boiler, the next smaller stack was almost as good, but for the lower nozzles (3, 2 and 1), the largest stack was in a marked degree better than any which were smaller, justifying the conclusion that if a stack as large as 18 ins. in diameter had been tried, the results obtained therefrom would have been given a place on the diagram. The same fact is indicated by the slope of the curves in Figs. 36, 40, 44 and 48.

Maximum results obtained from tapered stacks, plotted in a manner already described in considering the action of the straight stack, are presented as Figs. 96 to 99, inclusive. In this case, however, the several diameters of stack experi-

mented upon cover a range sufficiently wide to permit the selection of the best stack for all heights of stacks in combination with all heights of nozzles.

40. *Relation of Height to Diameter of Stack.*—The problem of stack design, as disclosed by the data already presented, is not to be regarded as one requiring a high degree of refinement. The data show that two stacks varying as much as 2 ins. in diameter sometimes give results which are almost identical. It happens in some cases, also, that a stack of a diameter which gives maximum results is almost equaled in its performance by a stack 2 ins. less and also by a stack 2 ins. greater in diameter. In such a case, a variation of 4 ins. in the diameter of the stack appears not to be significant. This is only true, however, with certain heights of stacks in combination with certain heights of nozzles, and as will be hereafter shown, the occurrence of such cases is more frequent in the case of tapered stacks than in the case of straight stacks.

It is evident, therefore, that it will be impracticable to determine within a small fraction of an inch the diameter of stack coresponding with any given height of stack and position of nozzle, which can be said to accurately represent the experimental results, for it is sometimes hard to say whether one or another of two stacks is the better. For the purpose, therefore, of reducing the various discordant elements to order, that a general law may be formulated, no harm will be done by employing a fair degree of liberality in interpreting the data.

Straight Stacks.—In order that the best relation of diameter and heights of stack may be stated, it will at first be necessary to eliminate variations in the height of the nozzles. Comparisons will, therefore, first be based upon results obtained with nozzle No. 3, this being the nozzle for which the tip is on the center-line of the boiler. From a study of the plotted spots of Fig. 92, it has been assumed that when the exhaust tip is on the center of the boiler, and the height of the stack is 26½ ins., the most satisfactory diameter, as disclosed by the data, is 15 ins., and a circle has been struck on the diagram (Fig. 92) to represent this value. Similarly, from Fig. 93 it appears that when the exhaust tip is on the center of the boiler and the height of the stack is 36½ ins., the most satisfactory diameter is 15.66, and a circle, the location of which corresponds with this value, has been struck on this diagram. In the same manner for the 46½ in. stack, the circle has been struck to represent a diameter of 16.33 in. and for the 56½ in. stack, the circle has been struck to represent a diameter of 17 ins. These, then, are assumed to be the best diameters of stacks for each of the several heights experimented upon, when the exhaust nozzle is on the center line of the boiler.

Stating these facts in the form of equations, in which d is the diameter of stack in inches, we have, for the engine experimented upon, the following:

For straight stacks 26½ ins. high:

$$d_1 = 15 = .28 \times 54.$$

For straight stacks 36½ ins. high:

$$d_2 = 15.66 = .29 \times 54.$$

For straight stacks 46½ ins. high:

$$d_3 = 16.33 = .30 \times 54.$$

For straight stacks 56½ ins. high:

$$d_4 = 17 = .31 \times 54.$$

For all of these values, the exhaust tip was on the center of the boiler and the diameter of the front-end of the boiler experimented upon was 54 ins. If, now, we may assume that the data obtained from the engine experimented upon is applicable to engines having boilers of different diameters, and if we may assume also that in applying the data to other engines, we may use the diameter of the boiler as a unit of measure, then the diameter of stack for any boiler whatsoever which has the exhaust tip on the center line should be represented by equations in which D, the diameter of the inside of the front-end, is substituted for the value 54 in the preceding equations. The result is as follows:

For straight stacks 26½ ins. high:

$$d_1 = 15 = .28 \times D.$$

For straight stacks 36½ ins. high:

$$d_2 = 15.66 = .29 \times D.$$

For straight stacks 46½ ins. high:

$$d_3 = 16.33 = .30 \times D.$$

For straight stacks 56½ ins. high:

$$d_4 = 17 = .31 \times D.$$

(To be continued.)

DIAGRAMS OF BEST RESULTS—STRAIGHT STACKS.

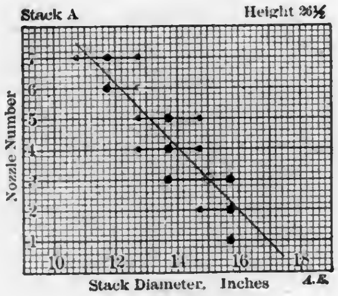


Fig. 92

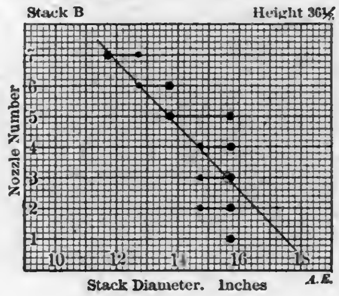


Fig. 93

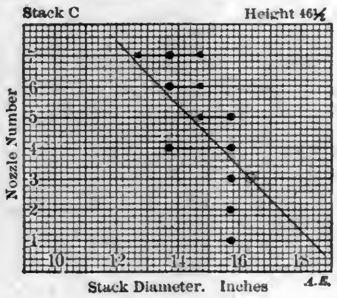


Fig. 94

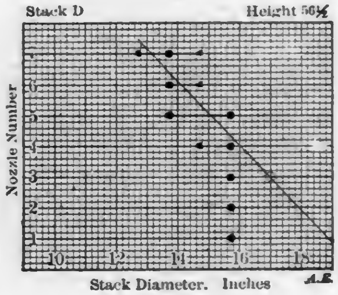


Fig. 95

DIAGRAMS OF BEST RESULTS—TAPER STACKS.

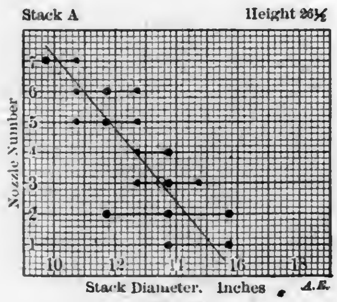


Fig. 96

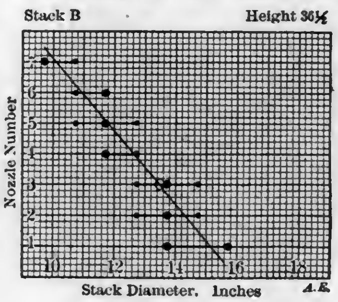


Fig. 97

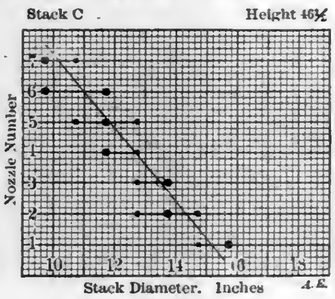


Fig. 98

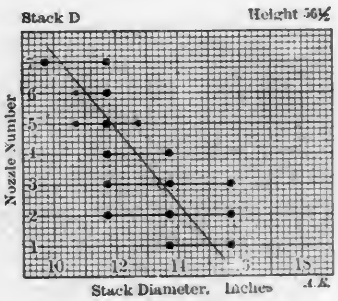


Fig. 99

NEW LOCOMOTIVE SHOPS, READING, PA.

Philadelphia & Reading Railway.

IV.

(For previous article see page 114.)

BOILER SHOP HYDRAULIC MACHINERY.

The illustrations on pages 111 to 113 of last month include the riveting tower and a plan of the hydraulic machinery in the boiler shop. These are now supplemented by descriptions of the flanging press, the riveter, the accumulator, and horizontal flange punch. This equipment was built and installed by Messrs. R. D. Wood & Co., Philadelphia.

FLANGING PRESS.

This press is of such size as to flange the heads of the largest locomotive boilers which have yet been designed; in fact, it goes farther than this, and makes provision for the largest locomotive boiler which we think it will be possible to design for use on the present railroads of the country. A general view of the press is shown by the accompanying illustration. This illustration shows the entire press, but when located in the shop the large moving central platen appears near the floor, the portion below this platen being out of sight below the shop floor. The clear distance between the upright columns is 8 ft. in one direction by 12 ft. in the other. These columns are made from forged steel, and of large diameters, to sustain with rigidity the immense strains brought upon them. The central moving platen carries one-half of the dies, with the complementary half secured to the upper platen by means of the tee slots shown. The moving platen is forced upward by the large operating ram, to which the water from the accumulator under 1,500 lbs. pressure is admitted by the movement of one of the small levers at the right-hand side of the illustration. This main ram exerts a pressure of more than 450 tons. After the hot steel plate from which the head is to be flanged has been placed on the dies carried by the moving platen, the four auxiliary clamping rams, all controlled by one of the small levers at the right of the illustration, carry the plate up and clamp it firmly against the die secured to the upper platen. When this is done the moving platen is forced upward by the main ram, and the flanging of the plate is completed. When it is desired to put a reverse flange for a door or manhole in the plate being flanged, this is accomplished by means of the overhead ram, which is adjusted radially from the center of the press, thus greatly economizing time and avoiding the necessity of reheating the plate for a second operation.

In addition to the flanging work, a large amount of other work is done on this press, including bending, punching and shaping of material required in the building of locomotives. The internal clamping ram exerts a pressure of 100 tons, and this pressure may be added to the effective pressure of the main ram, if desired. The four clamping rams also exert a pressure of 100 tons, and the overhead adjustable ram exerts a pressure of about 70 tons.

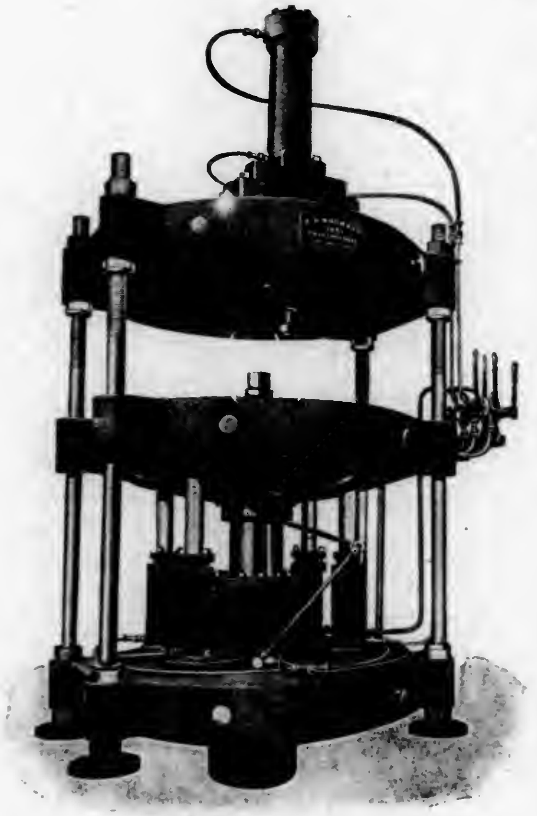


FIG. 1.—HYDRAULIC FLANGING PRESS.

FIG. 2.—HYDRAULIC RIVETER WITH THREE PRESSURES.

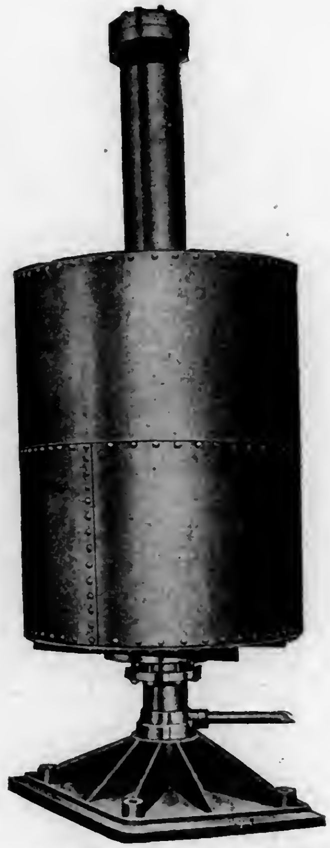


FIG. 3.—HYDRAULIC ACCUMULATOR.

HYDRAULIC RIVETER.

The hydraulic riveter (Fig. 2) is also designed for the maximum requirements of locomotive building, not only as they exist at present, but, so far as can be anticipated, as they will exist during the next twenty-five years. A large portion of this tool also is placed out of sight below the shop floor. The complete tool is shown by the accompanying illustration. With it the largest rivet can be closed at a point 17 ft. from the end of the boiler shell, this being the reach or depth of gap of the machine. The distance between the riveting stakes is unusually great, so that the firebox of the boiler may be swung under the riveting dies, thus enabling the riveter to reach practically all the rivets in the boiler. As the thickness of the plates to be riveted and the size of the rivets vary in different parts of the boilers, as well as in different sizes of

boilers, it will be readily seen that some provision should be made for furnishing different degrees of power to be applied for these varying conditions. The riveter is therefore supplied with what is termed a triple-power arrangement, which enables any one of three pressures to be exerted on the rivet, as desired. In order to turn from any one of these pressures to any other it is only necessary to move a small lever through a distance of a few inches. The three powers are secured by means of only two operating rams and one pull-back ram, thus making it necessary to have only three stuffing-boxes, all of which are easily accessible from the outside without dismantling the riveter. The small lever above referred to operates a valve of special construction, so arranged with three fixed positions that in the first position the water from the accumulator is admitted to the smaller operating ram, cutting it off from the larger ram; in the second position it admits the water to the larger ram and cuts it off from the smaller; in the third position it admits the water to both rams simultaneously. It will be understood that this valve is set as soon as the foreman of the riveting gang decides on the pressure he desires to use on the work in hand, and the operation of the riveter is controlled by the operating valve after this distributing valve has been set in the proper position. The

FIG. 4.—HORIZONTAL FLANGE PUNCH.

relative area of the two operating rams is as 1 to 2. It therefore follows that the intermediate pressure exerted by the riveter is twice the minimum pressure, and the maximum pressure is equal to the sum of the intermediate and minimum pressures. These machines are made to give the following pressures: 33, 67 and 100 tons; 40, 85 and 125 tons; 50, 100 and 150 tons. The riveter at Reading has the following capacities: 40, 85 and 125 tons.

FLANGE PUNCH.

The boiler heads, after being flanged, must, of course, be punched before they can be riveted into the boiler shell. For this purpose a special hydraulic horizontal punch is provided, as shown by the accompanying illustration (Fig. 4). This punch has capacity to punch a hole 1¼ ins. in diameter in 1¼-in. steel plate. It is provided with a flush top, so as to in no way interfere with the boiler head as it is hung over it. It is very quick in operation, and occupies far less space than the old style of geared punch which was formerly used for this purpose.

ACCUMULATOR.

The above tools are operated by a hydraulic accumulator, as shown in Fig. 3. This consists of a ram 12 ins. in diameter fitted securely into a cast-iron bed-plate. Over this ram operates an inverted cylinder, which carries a large steel tank containing the necessary ballast, having sufficient aggregate weight, which, added to the weight of the cylinder and tank, produces a pressure on the water of 1,500 lbs. per square inch. It acts as a large storage battery, storing up through a period of several minutes' inactivity of the tools a large amount of power, which is available for use at any instant and in any quantity desired. The pump which forces the water into this accumulator need therefore be of only small capacity, and can be arranged to operate almost continuously. The ballast material consists of iron scrap and punchings, and has a total aggregate weight of about 80 tons.

TOPEKA Y. M. C. A. CONFERENCE.

The eleventh international railroad conference of the Young Men's Christian Associations to be held in Topeka, April 30 to May 3, promises to be an important gathering. President Roosevelt is expected to attend, and among the other speakers are Dr. Elmore Harris, Dr. R. S. Henson, President Ramsay, of the Wabash; Governor Bailey of Kansas; General Manager Mudge, of the Santa Fe; Rev. Chas. M. Sheldon and Col. J. J. McCook. There will be a number of foreign delegates in addition to about 1,500 from this country. Inquiries for further information should be addressed to the Railroad Department, International Committee, Y. M. C. A., 3 West Twenty-fourth street, New York.

A GOOD JOB.

The following incident occurred a short time ago at the Baldwin Locomotive Works:

Mr. Vauclain, the general superintendent of the works, was riding on a freight elevator, which stopped at one of the floors to take on an old Irishman. A rule of the establishment forbade workmen using the elevator, unless they had a heavily laden wheelbarrow. This man had none; so Mr. Vauclain accosted him, saying: "Don't you know that you are not allowed to ride on this elevator without a wheelbarrow?" Sure, and where's your wheelbarrow?" responded Mike, not at all abashed. "Why, I am the general superintendent," exclaimed Mr. Vauclain. Very confidentially the old son of Erin leaned toward him and said, in a patronizing manner: "Then ye've got a blamed good job and ye'd better hould on to it."—*Philadelphia Ledger*.

The Winchester Repeating Arms Company have recently increased the capacity of their gas power plant at New Haven by the purchase of two 165 h. p. Westinghouse three-cylinder producer gas engines. This plant was the first American installation of gas power apparatus for industrial work, comprising originally about 500 h. p. in Westinghouse gas engine generator units and Loomis-Pettibone gas producers. The plant supplies electric light and power for operating the entire manufacturing establishment, and its operation up to the present time has been very satisfactory.

The draughting rooms of the engineering department of the Pennsylvania Railroad, in the Union Station, Pittsburg, have recently been fitted throughout with the Nernst lamp. The quality of the light delivered from this "glowing rod" type of electric lamp is peculiarly suited to the requirements of draughtsmen, having a perfect downward distribution of light of daylight quality, with an absence of shadow or flicker.

The electric high-speed trials on the Berlin-Zossen military railway were resumed with a new type of motor designed by Siemens & Halske, of Berlin. The heavy transformers previously used to reduce the pressure of the current from 10,000 volts to 2,000 volts have been dispensed with and current is delivered to the motors at 10,000 volts. The experimental track has been relaid with heavier rails, so that it is anticipated that a higher rate of speed, approaching 125 miles an hour, will be attained.

Mr. Edward E. Silk has been appointed secretary and general manager of the Holland Company, with headquarters at 77 Jackson Boulevard, Chicago. Mr. Silk is a graduate of Purdue University. He has had railroad experience on the Central Railroad of New Jersey, and was for two years associate editor of this journal. He recent resigned as Western representative of the O. M. Edwards Co. to accept his present position. The Holland Company has recently opened an office in San Francisco.

THE NATIONAL MALLEABLE IRON BRAKE JAW AND DEAD LEVER GUIDE.

These devices are shown in the accompanying illustrations, Fig. 1 illustrating the brake jaw and Fig. 2 the dead lever guide. The principal feature, which is common to both, is the method of attaching the rod. This is done without welding, which is necessary where a forged rod or guide is used. A connection is thus insured which is absolutely reliable under all circumstances. All welding being absolutely dispensed with, the danger of accident from imperfect welding is avoided, the rod does not require upsetting to form a head, and it is not necessary to drill for connecting pin holes. Thus not only is a substantial saving in time and labor effected, but greater safety is attained.

The application of the rod to the jaw is very simple. The jaw is slipped on to the rod through one of the two parallel holes in the end of the casting, then the end of the rod is bent over a mandrel into the form of a pot hook and slipped through the other parallel hole. The end is then slightly bent

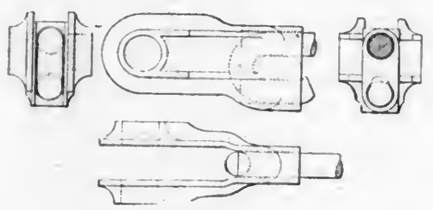


FIG. 1.

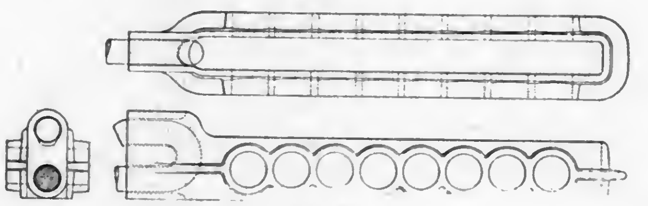


FIG. 2.

NATIONAL MALLEABLE IRON BRAKE JAW AND DEAD LEVER GUIDE.

over to prevent the jaw from slipping back. That the jaw is sufficiently strong and can absolutely be relied on will be seen from the following report of a test made at the Rose Polytechnic Institute:

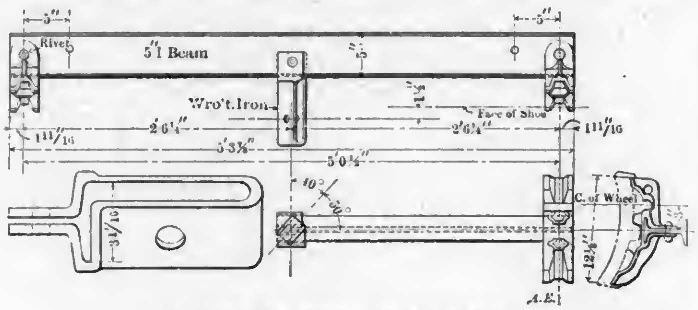
"The jaw was fitted with a ¾-in. iron rod, and with the stub end of a lever fitted in the end between the jaw. It was then put in a Rhiele testing machine and the pulling strain applied. The iron broke at 22,500 lbs. A bar of crucible steel was then applied instead of the ¾-in. iron and the jaw again submitted to the pull of the machine. This crucible steel broke at 35,100 lbs. strain, and we were unable to find anything sufficiently strong to hold the jaw to the breaking point of the casting. At the conclusion of the test the jaw was apparently in good condition with the exception that the holes for the pins were slightly elongated, but not sufficiently so to cause any difficulty in removing the pin."

These jaws and dead lever guides have been in service for five years and a broken one has never been reported, although there are at the present time over one hundred thousand in use. Many railroads and private car lines in all sections are now using them. The jaws and guides can be furnished for ¾, ⅞ and 1-in. rods and the jaws for either one or two connecting pin holes. Further information will be furnished by the National Malleable Castings Company, Cleveland, Ohio, by whom these devices are manufactured.

A point worth investigating in the selection of small direct-current motors is the arrangement of the brush holders. It is a good thing to have the brush holders permanently secured to the rocker so that the adjustment of spaces between brushes cannot be tampered with. If they are accidentally displaced in their location upon the rocker rigging, no end of sparking and heating will result.

A NEW VANDERBILT BRAKE BEAM.

The I-section brake beam of Mr. Cornelius Vanderbilt, which was illustrated on page 324 of our October number, 1902, has been improved and a wrought iron fulcrum applied, as illustrated in this engraving. This fulcrum is made so that it may be applied or removed without interfering with the brake heads. This beam, like the earlier one, is made by the Buffalo Brake Beam Company, 100 Broadway, New York. Another form has also been developed, in which the trussed construction with a channel compression member and a round



A NEW VANDERBILT BRAKE BEAM.

section tension member are used. In this case the fulcrum has a swiveling central portion which is adjustable and reversible, making the same beam either right hand or left hand. The wrought-iron fulcrum above referred to has a tensile strength of from 50,000 to 65,000 lbs., with 25 per cent. elongation, as compared with about 30,000 lbs. and 10 per cent. elongation, which is obtained with malleable iron.

THERMIT.

The thermit process of cast-welding has been brought to this country from Germany and it is worthy of attention. "Thermit" is a mixture of aluminum and oxide of iron in proportions suitable for chemical reaction, which takes place under the influence of heat produced by the ignition of a small amount of superoxide of barium powder, which may be started with a match. Thermit was produced by Herr H. Goldsmith, a German chemist, as a result of investigations made for the purpose of obtaining chromium, free from carbon, for use in steel manufacture at the Krupp works. Finely divided chromium was discovered to possess the property of taking oxygen from oxide of iron, provided the mixture is in propor proportion and is heated sufficiently to start the chemical reaction. The reaction is very rapid and the resulting temperature about 5,400 deg. F. Graphite crucibles will not stand the heat and special crucibles are required. In the reaction pure melted steel is produced, and this, because of its high temperature, produces solid welds with wrought iron, cast iron or steel. It will produce welds in large or small pieces and has been successfully applied in repairing broken marine crank-shafts, defective cylinder castings and in welding steel rails. Besides the melted steel an alumina slag is produced, which is really corundum, and is available for abrasives. To use thermit a mold is made around the part to be welded and the reaction is produced by the proper amount of the material in a crucible supported over the mold. The entire process is very simple and easy. It is specially adaptable to the welding of rails, and doubtless equally so to repairing broken locomotive frames and castings. Readers are referred to the March issue of *Machinery* for an illustrated description of the process.

By the systematic use of the term engine "driver" when a locomotive engineer is referred to, one of the New York dailies is evidently attempting to Anglicize an important calling and belittle a large class of intelligent men. It is to be hoped that the snobbery which led to the successful effort of the aristocracy of the navy to degrade the engineers will not be reproduced on the railroads. There is no such employee as an "engine driver" on any railroad in the United States and it is hoped that there never will be.

TABLES OF CUTTING SPEEDS.

FOR MACHINE HANDS.

It is one thing to install up-to-date machine tools and high-speed tool steels and it is quite another thing to be sure that they are used to the best advantage. The foreman is not always at hand for consultation, and even if he could be the man running a new tool should have the advantage of all the information which can be given him in order to get the work done in the quickest way. To give these men such assistance, Mr. L. R. Pomeroy suggests an adaptation of an idea from Mr. Donaldson's paper before the Institution of Mechanical Engineers.

Upon a brass plate attached to the machine—a lathe is selected for illustration—the cutting speeds and revolution of the spindle for a piece 1 in. in diameter would be given and arranged as in the accompanying table. For each different kind of material the best cutting speed is shown. For pieces of larger diameters the revolutions are easily obtained by dividing by the diameter, the required spindle speed being the r. p. m. for 1 in. diameter, divided by the given diameter of the work. In order to enable the workman to obtain the correct number of revolutions, each step of the cone pulley could be stamped with the number of revolutions which it will produce at the spindle with single, back or triple gears. In the table the various materials are represented by initials, which are explained.

While the new rapid cutting tool steels give speeds from six to ten times those of ordinary steels in soft material, the speeds for harder material do not keep up this ratio. Perhaps the makers have in mind the demands for rapid removal of large quantities of mild or moderately hard material—that is to say, "rapid reduction." A table of this kind should be carefully compiled from experiments.

A PLATE FOR A LATHE.

Material.	Rev. of Spindle for 1 In. Diameter.	Corresponding Cutting Speed in Ft. per M.
S. V. H.	58	15.
S. H.	84	22.6
S. M. H.	102	26.7
S. T.	107	28.
S. S.	105	22.4
I. W.	210	55.
I. C.	80	21.
B. H.	468	122.
B. S.	860	224.
B. F. H.	615	160.
B. F. S.	530	138.

S. V. H.=Steel, very hard.
S. H.=Steel, hard.
S. M. H.=Steel, medium hard.
S. T.=Steel, tough.
S. S.=Steel, soft.
I. W.=Wrought iron.
I. C.=Cast iron.
B. H.=Brass, hard.
B. S.=Brass, soft.
B, F. H.=Brass, forged hard.
B. F. S.=Brass, forged soft.

The application of steam turbines to driving centrifugal pumps for boiler feeding is the boldest step thus far taken in connection with the development of these interesting machines. Information has been received from a reliable source concerning a battery of boilers carrying 200 lbs. pressure which are fed in this way.

BOOKS AND PAMPHLETS.

Elements of Steam Engineering. By H. W. Spangler, Professor of Dynamical Engineering, University of Pennsylvania; A. M. Greene, Jr., Professor of Mechanical Engineering, University of Missouri, and S. M. Marshall. 275 pages; illustrated. John Wiley & Sons, 43 East Nineteenth street, New York. 1903. Price, $3.

This book is to give beginners in the study of mechanical engineering a general knowledge of the essentials of apparatus used in steam power plants. It illustrates and explains the purpose of boilers of various types, boiler-room accessories, steam engines, valves, indicators, governors, condensers and multiple-expansion engines. It does not present theory and is elementary. It is evidently intended as a preparation for theoretical studies and should be read at the very beginning of a mechanical course. It is well illustrated and has a convenient index. It is an excellent book to give the beginner a "working vocabulary."

Manual for Resident Engineers. By F. A. Molitor and E. J. Beard. John Wiley & Sons, 43 East Nineteenth street, New York, 1903. 118 pages. Price, $1.

This book is printed on small pages and is easily carried in the pocket. It primarily comprised the instructions to resident engineers on the Choctaw, Oklahoma & Gulf Railroad, but has now been put in more complete form, with the addition of specifications for graduation, masonry, lumber, and also of tables of level cuttings for various widths and slopes. These instructions are well given and anyone of experience is likely to find some points of value touched upon in the way of new suggestion. To anyone new to the work, the volume should prove of special interest. There are a number of pages of sample notes and a sample bit of profile showing among other things the arrangements for haul of materials.

Report of Examination of Water Supply of Middle Division, Atchison, Topeka & Santa Fe Railway.

In November of last year the Kennicott Water Softener Company made an elaborate investigation of the boiler waters of 18 entire divisions of the Santa Fe Road and embodied the results in a report, the like of which has never been attempted before. They have reproduced in miniature form the report of the middle division comprising 29 water stations, and readers of this journal are advised to secure copies for permanent record. The report opens with a table and comparative chart showing the relative amounts of incrusting solids before treatment and the results to be had from softening. The next chart shows the number of pounds of incrusting solids entering the boilers at each station for every 24 hours. The amounts range between 4.03 and 696 lbs. for this division. This illustrates the importance of considering the amount of water used as well as its quality. Another chart shows the possible reduction in sodium carbonates in the waters containing that substance. Following this is a table of total consumption and capacities of the softeners recommended, together with the number of hours of operation required daily. Information concerning the various incrusting impurities is presented and the pamphlet closes with the individual analyses of all of the waters of the division, with remarks upon each. In these analyses the figures for incrusting solids are given prominence by red ink. This is one of the most convincing exhibits in favor of water treatment that we have seen and it conveys the impression that the authors of the report thoroughly understand their subject. It is presumed that copies may be had upon application to the office of the company, 77 Jackson Boulevard, Chicago.

Steel Rolling Doors, Shutters and Partitions.—The Columbus Steel Rolling Shutter Company, Columbus, Ohio, has issued a new catalogue of their steel shutters showing the construction of the sheets and illustrating applications to freight houses and other buildings. This company has recently equipped the Hocking Valley shops and freight sheds, also the new shops of the Pennsylvania Lines West of Pittsburg, and a number of car houses for electric roads in Ohio and Indiana. The shops are working "double turn" and the company expects to move into the outskirts of the city of Columbus to obtain increased facilities for manufacturing and shipping.

The American Tool Works Company, of Cincinnati, Ohio, have made a number of changes in the personnel of their management. Mr. Franklin Alter is president; Henry Luers, secretary and treasurer; J. B. Doan, general manager; A. E. Robinson, general superintendent. All departments are very busy and the outlook for future business is such as to require extensive additions and alterations to the plant. A number of new tools have recently been brought out with gratifying results.

C. H. Whall & Co., 170 Summer street, Boston, have issued an attractive little pamphlet directing attention to their metallic window casing for passenger cars and other windows. This construction provides a dust and weather proof and rattle proof window which can at all times be easily moved. Two elastic metal casings are secured to the window frame and grooves are made in the sash to fit the rounded edges of the casings. The sides of the sash are embraces between the two casings with sufficient pressure to insure tight joints but not to prevent easy movement. Side sash locks are not necessary, as the casings hold the window open at any desired point. This company also manufacture fiber insulations and fusees.

EQUIPMENT AND MANUFACTURING NOTES.

The National Brake Shoe Company, 620 Atlantic avenue, Boston, has succeeded to the business of the Allston Foundry Company, and will continue the manufacture of the "Compo" brake shoe for steam and electric railway service.

The O. M. Edwards Company has secured the services of Mr. J. E. Simons as general manager. Mr. Simons was formerly in charge of the rolling stock of the Pittsburgh Coal Company and is widely known among railroad men from his long experience with them and his activity in the Master Car Builders' Association.

Mr. Edgar N. Smith, formerly roadmaster on the B. & M. R. Railroad in Nebraska, and previous to that on the N. Y., N. H. & H. and the Boston Elevated, has accepted a position with the Railway Appliances Company, giving his time particularly to the Q & C.-Bonzano rail joint.

The Railway Appliances Company has secured the car vestibule diaphragm business of the E. J. Ward Company, including material and machinery. These diaphragms will be manufactured at Chicago Heights. Mr. C. C. Murray has joined the staff of the Railway Appliances Company and will devote his attention to the Q. & C. pneumatic tools, with headquarters in Pittsburgh.

The Northern Metallic Packing Company has been incorporated at St. Paul, Minn., with a capital of $50,000, to conduct a general manufacturing business. Its specialties are Northern Metallic Packing, Curran Locomotive Chime Whistle, the Furhman-Nelson Pneumatic Motor and other railroad specialties. The officers are Alfred Munch, president; L. B. Mack, vice-president; S. R. Parslow, treasurer, and D. E. Anderson, secretary.

The Westinghouse Air Brake Company will at once begin the erection of a new foundry to be 320 x 65 ft. and constructed of brick with steel frame. This foundry will be located just west of the present works at Wilmerding, and has been made necessary by the greatly increased demand for castings used in the apparatus manufactured by this company. Owing to the development of the traction brake business, the air brake company's present foundry facilities have been overtaxed for some time past and in order to insure greater efficiency in production and prompt delivery of material it has become necessary to provide greater capacity. This addition to the plant will materially increase the working force, now numbering about 3,000 men.

The Pittsburg & Lake Erie Railroad has ordered from the Kennicott Water Softener Company ten automatic water softener plants. The largest of these is to be installed at the McKees Rocks shops and will have a capacity of 60,000 gals. per hour. In connection with it two 500,000-gal. steel storage tanks. 50 ft. in diameter and 40 ft. high, will be erected. The water will be pumped from a deep well with a pumping capacity of 2,000 gals. per minute in centrifugal pumps driven by electric motors. The plans are arranged to duplicate this softener when it is required. At the terminal station a small machine of 15,000 gals. per hour will be put in. At Hazelton, Newcastle Junction, Rock Point and Groveton machines of 42,000 gals. hourly capacity will be used, and at Stobo, Williamsburg, Buena Vista and Whitsett Junction machines of 21,000 gals. per hour. This order is placed in accordance with a plan to install water purification plants over the entire road so that locomotives will take no raw water for use in their boilers. The Union Pacific has just placed an order for 25 more Kennicott water softeners and have adopted it as standard. The smallest one in the order is of 10,000 gals. capacity per hour. This is the third order from the Union Pacific and it raises the total capacity of these softeners in use on one order to 20,034,000 gals. per day.

The Allis-Chalmers Company will move on May 1 from the Home Insurance Building to the New York Life Building, La Salle and Monroe streets, Chicago. This is part of the progressive programme of this concern, which includes large expenditures for betterments at Milwaukee, Chicago and Scranton, all of which are undertaken in order to secure the best service and prompt deliveries. An idea of the scope of the business is had from the statement that in the past two months orders for engines, mining, rock-crushing, saw-mill or flour-mill machinery have come from every State in the Union, besides the following foreign countries: England, South Africa, Mexico, Canada, Chili, Central America, Brazil, West Australia, Turkey, Finland, Yukon Territory, Belgium, British Columbia, Bolivia, Hawaiian Islands, Peru, Alaska, China and the Philippine Islands.

Mr. George E. Martin has resigned as superintendent of the shops of the Pedrick & Ayer Co.

Webb C. Ball, of Cleveland, O., has been appointed chief watch inspector of the Rutland Railroad, with headquarters in Cleveland.

Mr. J. D. Hurley and Mr. A. B. Holmes, who were formerly connected with the Standard Pneumatic Tool Company, are now associated with the Rand Drill Company, in the "Imperial" pneumatic tool department.

The Pittsburgh Filter Manufacturing Company have opened a New York office at 29 Broadway. Mr. R. Dorn, formerly connected with the Industrial Water Company, will be in charge. The address of the Pittsburgh Filter Manufacturing Company in Pittsburgh has been changed from the Empire Building to the Farmer's Bank Building.

The Baltimore Railway Specialty Company has been formed to take over the business of the Baltimore Ball Bearing Company, which was organized by Mr. J. E. Norwood to manufacture his ball-bearing center plates and side bearings, which were illustrated on page 208 of our July issue of last year. The officers of the new company are: President, T. H. Symington; vice-president, J. W. Middendorf; secretary and treasurer, W. Eason Williams; mechanical engineer, J. E. Norwood. The capital is $900,000.

The Chicago Pneumatic Tool Company have appointed Mr. Henry Engels western sales agent on the Pacific Coast, with headquarters with Messrs. Eccles & Smith, 91 Tremont street, San Francisco, Cal. All Pacific Coast business will be cared for at that office. Messrs. Eccles & Smith will continue in their capacity of general agents and they will be assisted by Mr. Engels. The company reports an increase in the already heavy demand for their product in this and foreign countries.

The Babcock & Wilcox Co. have won their suit against the Aultman & Taylor Machinery Company and Thayer & Co. for infringement of their trade name, and a perpetual injunction was issued against the defendants, enjoining them from using the name "Babcock & Wilcox" or the initials "B. & W." in connection with the sale of any boiler not manufactured by the Babcock & Wilcox Co. This firm name and initials identify the product of this company and have done so for many years, representing a high reputation gained by invariable integrity. They cannot be lawfully used in connection with the boilers of any other company. This action by the United States Circuit Court is an important one.

The Fort Pitt Spring and Manufacturing Company announce that they are manufacturing railway springs and are ready to execute orders for spiral railway springs of any capacity and for any purpose. They are in position to insure prompt deliveries, as their equipment is modern and up-to-date in every respect. The plant is under the personal charge of Mr. Martin B. Foley, who has for a number of years had charge of the spring departments of the Crescent Steel Company and Anderson, Dupuy & Co., which was later the Crucible Steel Company of America, and afterward with the Railway Steel Spring Company. This wide experience enables him to meet the severest requirements. The offices of the company are at McKee's Rocks, Pa.

A. Leschen & Sons Rope Co., of St. Louis, manufacturers of wire rope and aerial wire rope tramways, have opened an office and warehouse at 1717 Arapahoe street, Denver, Col., where a complete stock of wire and manila rope will be carried. This is the fourth branch office and warehouse opened by them. They make not only all ordinary grades of wire rope, but are the sole manufacturers of Hercules colored strand and patent flattened strand wire rope. They also manufacture automatic tramways which load and unload automatically, several types of friction grip tramways, single and two-line bucket tramways.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

RAILWAY SHOPS.

BY R. H. SOULE.

IV.

THE MACHINE SHOP.

The machine shop floor area per erecting shop stall, for a large number of shops, both repair and construction, has been given in Table 7, an analysis of which discloses the fact that although there are wide limits of practice, there is nevertheless evidence that a liberal provision of machine shop floor space very favorably affects erecting shop output. The exact amount of machine shop floor space which it is best to provide for a given installation is an economic problem which involves consideration of the questions of interest on capital, land values, etc. The design of a machine shop not being limited to a few types, but in fact admitting of great variations, it is not practicable to give one or more typical cross sections, as was done in the case of the erecting shop, but certain essential features may be considered and discussed.

Good practice requires the use of firm floors. Where laid on earth a stratum of concrete should be interposed. This need not necessarily be the usual cement sand and broken stone mixture, but rather some cheaper substitute which may make use of locomotive front end cinders flushed with tar or asphaltum, the whole covered by a layer of planking and a thinner top dressing which may be easily renewed in spots. Such a floor construction makes foundations quite unnecessary, except for a few of the heavier tools; these and other tools which have individual electric drives are relieved from belt pull tending to lift them from or shift them on their foundations, while lighter shaft driven tools may be fastened down with lag screws or hook bolts. In a two-story structure the upper floor should be of heavy planking, with top dressing as before.

The loss of time resulting from the use of two-story structures for machine shop purposes, though indeterminate, is nevertheless actual and inevitable, and that form of construction should not be resorted to unless for the reason that land is obtainable only at a prohibitive price. In addition to the loss of time resulting from the transportation of men and materials, there is a loss of floor space, repeated on each floor, where stairways and elevators are provided, and the loss which comes from the impaired lighting of the lower story. Besides this it is often necessary to introduce columns to support the second floor and these are an obstruction and interfere with the grouping of tools and the movement of men and materials on the first floor.

In the machine shop department of the average locomotive repair shop it is seldom the case that tools occupying more than one-third of the total floor space can be served to best advantage by an overhead traveling crane, and it so happens that these are the tools which are best adapted to the individual electric drive and do not require overhead shafting. If driving wheels are stored inside the building it may be necessary to increase the amount of floor space covered. The balance of the tools can be better served by local and individual cranes and hoists, which also permit of the placing of shafting and motors overhead. Every machine shop should be so designed that all shafting may be hung either from the roof trusses, from walls, or from structural columns, as floor stands for shafting support are very much in the way and occupy space which is valuable for other and more legitimate purposes. The walking crane is not as well known in this country as in England, but as modernized and adapted to be electrically driven is a very satisfactory appliance. It takes up a minimum of floor space and head room, has a deck on which material may be laid, does not require highly skilled labor to operate, and leaves the operator free to assist in adjusting slings, etc., which cannot be done by traveling crane operators.

The traveling crane equipment and the head-room of several machine shops are given in Table 8. A capacity of ten tons appears to be sufficient for the traveling crane. Its heaviest load would probably be a pair of cylinders bolted together, which, in the case of some compound engines, weigh upwards of eight tons. When the head-room figures are examined in connection with the designs from which they were taken it is found that certain apparently excessive dimensions are accounted for by structural considerations. Eliminating these it would appear that in one story machine shop structures 25 ft. is sufficient head-room in a crane bay (of moderate width), while 20 ft. is liberal in a bay where cranes are not used. When these limits are exceeded it is for structural reasons (as stated before) or, in the case of very broad shops, to secure better lighting. Where there is a second story in a bay where cranes are not used the head-rooms on the first and second floors might be taken as approximating 18 and 15 ft. respectively.

TABLE 8—TRAVELING CRANE EQUIPMENT AND HEAD-ROOM IN SEVERAL TYPICAL MACHINE SHOPS.

Place.	Railroad.	Year Built.	Traveling Crane Equipment.	Head-room (Approximate): Where Cranes Are Used. Ft. Ins.	Head-room (Approximate): Where Cranes Are Not Used. 1st Floor. Ft. Ins.	Head-room (Approximate): Where Cranes Are Not Used. 2d Floor. Ft. Ins.
Depew, N. Y.	New York Central	1893	....	.....	22—0	.....
Concord, N. H.	Boston & Maine	1897	....	.....	18—0	.....
Chicago, Ill. (Annex)	Chicago & Northwestern	1900	....	.....	18—0	13—0
Oelwein, Iowa	Chicago Great Western	1900	1 15-ton	33—6	17—9	14—7
Fond du Lac, Wis.	Wisconsin Central	1900	2 5-ton	22—9	22—9	.....
Hannibal, Mo.	Hannibal & St. Joseph	1901	....	.....	16—4	16—4
Dubois, Pa.	Buffalo, Rochester & Pittsburg	1901	....	.....	20—0	.....
Elizabethport, N. J.	Central Railroad of New Jersey	1902	{1 10-ton, 1 5-ton}	30—9	20—3	.....
Reading, Pa.	Philadelphia & Reading	1902	2 10-ton	33—5	Cranes	throughout
Baring Cross, Ark.	Missouri Pacific	1902	....	.....	21—0	.....
Omaha, Neb.	Union Pacific	1902	2 10-ton	40—0	19—0	17—6
Pocatello, Idaho	Oregon Short Line	1902	1 10-ton	39—0	19—0	17—6
Jackson, Mich.	Michigan Central	1903	1 7½-ton	.....	18—6	.....
Topeka, Kan.	Atchison, Topeka & Santa Fé	1903	2 5-ton	20—0	15—0	12—0
Oak Grove, Pa.	New York Central	1903	....	.....	18—0	.....
Montreal, Can.	Canadian Pacific	1903	2 10-ton	32—9	19—0	17—9
McKees Rocks, Pa.	Pittsburg & Lake Erie	1903	....	25—9	Cranes	throughout

The structural designs and specifications of a building to be used as a machine shop should require that the members, whether roof trusses or floor girders, from which shafting, hoists, etc., are to be hung, should be built truly horizontal, without camber, and should expose below broad flat surfaces with flanges, over the edges of which hook bolts may be attached. This construction permits the attachment of supports for shafting, hoists, etc., without drilling holes in metallic members, and facilitates slight changes of location, which often become necessary.

The selection of tools for the machine shop is a matter of critical importance, especially under existing conditions, when tools are being redesigned and their output modified by the use of new cutting steels and the electric drive. The safest way in the case of a new and large plant would be to organize a special commission to deal with the question and prepare the list. Two or three men who had actual charge in large shops

and say two representatives of the tool manufacturers could, by comparing the tool lists of existing plants, jointly determine the requirements of the plant under consideration. It is not simply a question of the design and specification of each individual tool, but also the question of how many tools of each kind are needed in order that work on the several parts of the locomotive may progress at such a rate that the finished work will be ready a little in advance of the schedule time when it may be required.

The location and grouping of tools may be governed by a few general principles. The heavier tools (say those requiring 5 h. p. or over to drive) should be located under a traveling crane. Tools working exclusively on castings should be placed near the point at which castings are received into the shop. Those working exclusively on forgings should be placed near the receiving point for forgings. Different tools engaged on the various processes of producing one finished article should be grouped together. Sufficient floor space adjacent to each tool should be reserved for the storage of a reasonable quantity of raw material and finished product. Passageways for the movement of men and material must be reserved.

In applying these principles to a given plant it will at once be found that their claims are often conflicting, and that a judicious compromise must be effected. Such necessary compromise should never fail, however, to provide direct passageways for the movement of material along those lines on which the work naturally progresses. In a locomotive shop, whether for construction or repairs, a great advantage is gained if driving wheels can be handled entirely by the same cranes that cover the erecting stalls; otherwise the wheels must be rolled from one crane bay to another, which seems easy, but is actually a laborious operation, and open to many inconveniences and objections, owing to the excess of counterbalance. Custom has placed the heavier tools on that side of the machine shop nearest to the erecting shop; this practice has undoubtedly been copied from locomotive construction shops, but can hardly be justified for repair shops, where the aggregate movement of high priced labor between locomotives and light tools greatly exceeds the aggregate movement between locomotives and the heavy tools, this latter being done, moreover, by cheap labor.

Although a layout plan showing tool locations should always be made in advance, yet it should never be regarded as final, and the person having charge of the actual placing of the tools in the shop should be empowered to make considerable variations in the location of individual tools, provided the general scheme of grouping is adhered to. After all the tools have been actually located a final layout plan may be made for purposes of record. In this connection it should be stated that in general it is cheaper in the end to duplicate lighter tools, say up to a value of $500 each, rather than to be compelled to transport material long distances from some other tool by which it has been partly finished. The duplication of such light tools in different places is simply a recognition of one of the principles mentioned above.

The best method of driving tools is undoubtedly the electric drive applied individually to the heavier tools, to isolated tools, to those lighter tools which require the use of variable speed, and applied collectively to groups of such lighter tools as may be economically run at approximately constant speeds. Under present conditions direct current best meets all the conditions, but when the induction motor can be made to give a variable speed then the alternating current will undoubtedly be the primary current, which may be transformed into direct current for the few remaining applications where the direct current will give better results. Every electrically driven shop should have motor speed control attachments to certain motors, but it is not possible to here discuss the relative merits of rheostatic control, field control, or multi-voltage control, which may be combined and modified in various ways. Data on the power required to drive individual tools has been accumulating so rapidly since the electric drive was introduced that the rating of tools has become comparatively easy; similarly, enough completed plants have been in operation under close observation to enable the designer of new plants to assume a load factor for group drives which will insure an abundance of power at the tools on the one hand and on the other will keep the size of the motor down to an economical limit.

A well appointed tool room should be a feature of every machine shop, but its scope and design admit of such wide variation that no standard proportions can be established. The principal requisites are that its location should be central and its equipment complete and liberal.

(To be Continued.)

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

REPORT BY PROF. W. F. M. GOSS.

XVI.

SECTION VI., ARTICLE 40. (Continued.)

(Continued from Page 155.)

If, now, an expression can be found which can be substituted for the coefficient of D and which will represent the height of stack in inches in each of the four equations, it will be possible to write a single equation in the place of four. That this may be more readily accomplished, the values representing best diameters with which we have been dealing were so chosen that while doing no violence to the experimental data, they will, when plotted in terms of height-of-stack, and diameter-of-stack, fall upon the same straight line, all as shown by Fig. 100. This fact makes it possible to write in simple form a general equation expressing the relation thus defined. Thus, by Fig. 100, it is apparent that when the stack height is zero, the diameter is equal to something over 13 ins. (more exactly 13.28) and the slope of the line connecting the several experimental points is such that with each inch height of stack, the diameter increases .00123 in. $\times$ 54. If, as in the previous case, we may convert the expression, which as it stands applys only to the Purdue locomotive, into a general expression, by substituting D for the diameter of boiler (54 ins.) we may write as the coefficient of D, in the four preceding equations,

$$(.246 + .00123\ H)$$

in which H is the height of the stack in inches.

As proof that this expression satisfies the conditions of the four equations preceding, we may substitute in succession the several values of H for which the preceding equations apply, and obtain in each case a result which will be identical with the coefficient of D which is there written. Thus:

In the preceding equation for stacks 26½ ins. high, the coefficient of D is .28. Making the H which appears in the proposed coefficient equal to 26½, we have:

$$(.246 + .00123\ H) = .246 + .00123 \times 26.5 = .2785.$$

Similarly, for stacks 36½ ins., the coefficient of D is 29; for stacks 45½ ins. the coefficient is .30; and for stacks 56½ ins. the coefficient is .31, respectively. The general expression for each of these coefficients is:

$$(.246 + .00123\ H) = .246 + .00123 \times 36.5 = .2908$$
$$(.246 + .00123\ H) = .246 + .00123 \times 46.5 = .3031$$
$$(.246 + .00123\ H) = .246 + .00123 \times 56.5 = .3154$$

We may, therefore, write for any straight stack when the exhaust nozzle is on the center line of the boiler,

$$d = (.246 + .00123\ H)\ D$$

d being the diameter of the stack in inches when the exhaust nozzle is on the center line of boiler, H the height of the stack in inches, and D the diameter of the front end of the boiler in inches. A liberal interpretation of this equation is to the effect that the diameter of a straight stack should be approximately one-fourth the diameter of the front-end plus .0012 inch for each inch in height. Modification in the form

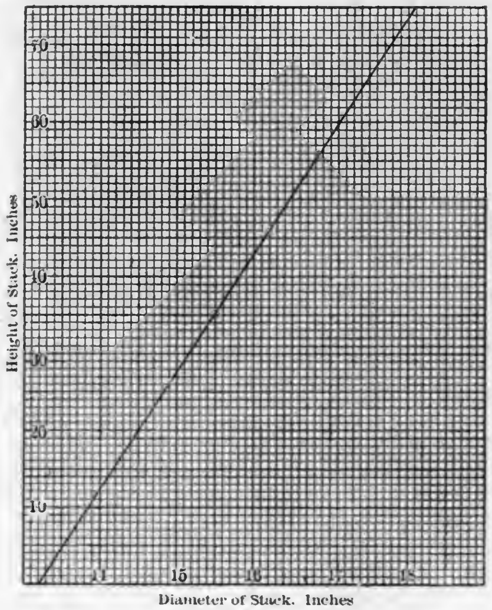


Fig. 100

RELATION OF DIAMETER TO HEIGHT OF STACK FOR THE PURDUE EXPERIMENTAL LOCOMOTIVE FOR BEST RESULTS WHEN EXHAUST NOZZLE IS ON CENTER LINE OF BOILER.

ins., gives maximum results for all heights of stack between the limits of 26½ ins. and 56½ ins. In other words, unlike the straight stack, the diameter of the tapered stack does not need to be varied with changes in the height.

Stating this fact in the form of an equation, therefore, we have for a tapered stack upon the Purdue engine, the diameter of the boiler of which is 54 ins., the following:

$$d_a = 13.5;$$

also

$$d_a = 13.5 = .25 \times 54 \text{ ins.}$$

Assuming that the results thus obtained from the experimental engine may be applied to other engines having different diameters of boilers, and using the diameter of the boiler as a unit of measure, we may write for all locomotives, and for all heights of stacks where the exhaust tip is on the center of the boiler:

$$d = .25 \text{ D}$$

in which d is the least diameter of the tapered stack when the exhaust tip is on the center line of boiler and D is the diameter of the front-end of the boiler.

Expressing this relation in words, it is to the effect that when the exhaust nozzle is on the center line of the boiler, the least diameter of tapered stack should be one-quarter the diameter of the front-end of the boiler.

41. *The Effect of Changes in the Height of the Exhaust Nozzle upon the Diameter of Stack.*—For the purpose of passing from the results obtained from the experimental engine to

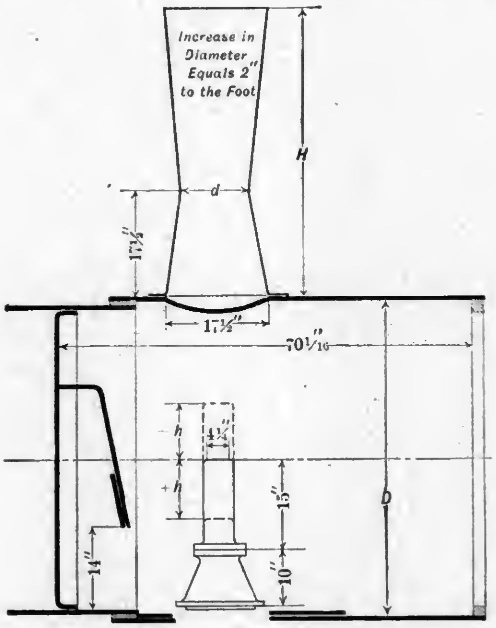


Fig. 101

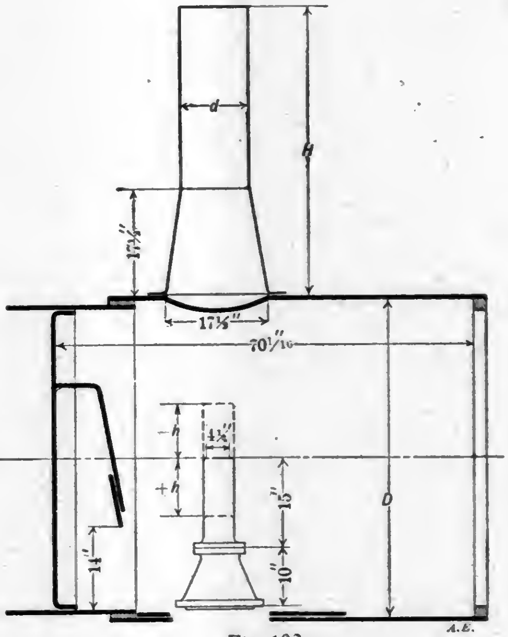


Fig. 102

of this equation to satisfy the condition arising from varying heights of exhaust nozzle will be hereafter considered.

Tapered Stacks.—The best results attending the use of the tapered stacks of each different height experimented upon in connection with the seven different heights of exhaust nozzles, appear in Figs. 96 to 99, inclusive. In these diagrams, the experimental results are shown by means of black spots connected by horizontal lines in the manner already described in connection with the straight stack. When two stacks give equally good results, both points are located and the spots connected by a horizontal line, and where a larger or smaller stack gives results almost as good as the best, a line is extended in its direction terminating in a small spot midway between that representing the best stack and the position representing the stack which is almost as good.

Proceeding, as in the case of the straight stacks, to locate a representative point in line with Nozzle No. 3, which will fairly represent the experimental data, choice has been made of the diameter 13½ ins., and a circle drawn upon all diagrams while at this diameter. It appears, therefore, that an important conclusion to be derived from the experimental data is to the effect that a tapered stack having a least diameter of 13½

those to be expected from engines having boilers of other diameters, using the boiler diameter as a unit of measure, it has been necessary thus far to deal with conditions for which the parts are symmetrically arranged. It is for this reason that the central position of the nozzle is the only position which has been employed. We may now consider the influence upon the diameter of the stack resulting from changes in the height of the nozzle.

The points represented by the circles (Figs. 92 to 99) and which have been the basis of equations thus far written, have been so located that it is possible to draw through each of them a straight line which will fairly represent the best diameter of stack for all heights of nozzles. The oblique line which appears in the several figures may be regarded as such a line. It now remains to find an expression for this line which can be added, as a new term, to the equation which has already been deduced, for the purpose of modifying the final results as demanded by the differences in results obtained when changes are made in the height of the nozzle.

Straight Stacks.—In Figs. 92 to 95, inclusive, representing the straight stacks, the oblique lines representing the relationship between diameter of stack and height of nozzle as dis-

closed by the experimental data have all been drawn straight and at a constant angle. The slope of the line is such that assuming the effect of the nozzle in Position 3 to be zero, the effect upon the diameter of the stack of each inch change in the height of the exhaust nozzle equals .19 of an inch. It is evident that this correction will effect an increase in the diameter of the stack when the nozzle position is below the center line of the boiler, and a decrease in the diameter of the stack when the exhaust nozzle is above the center line of the boiler. We may, therefore, write as a new term in the equation giving the best diameter of a straight stack,

$$.19\,h$$

in which h is the distance in inches between the center line of the boiler and the exhaust tip, the sign preceding this term being positive when h is the distance below the center line, and negative when h is the distance above the center line.

Tapered Stacks.—A similar process gives the constant representing the change in effect to changes in the height of the nozzle for the tapered stack, excepting that for this stack, the slope of the line (Figs. 96 to 99) is different and the constant is different. Its value is represented by .16. Thus, to measure the effect of changes in the height of nozzle on the diameter of the stack, we may, for the tapered stack, write:

$$.16\,h,$$

the sign preceding the term being postive when h is distance below the center line and negative when h is distance above the center line.

42. *Equations Giving Stack Diameters for Any Height of Stack between the Limits of 26 Ins. and 56 Ins., and Any Height of Nozzle between the Limits of 10 Ins. Below the Center of the Boiler and 20 Ins. Above the Center of the Boiler, and for Any Diameter of Front end.*—Combining the expressions of the two preceding paragraphs, we may have equations giving diameter of stack in terms of its height, diameter of front-end, and the distance between the center-line of the boiler and the top of the exhaust tip. These several equations obviously are the equations of the oblique lines appearing in the corresponding diagrams, Figs. 92 to 99. They are as follows:

For Straight Stacks:

When the exhaust nozzle is below the center line of the boiler,

$$d = (.246 + .00123\,H)\,D + .19\,h.$$

When the exhaust nozzle is above the center line of the boiler,

$$d = (.246 + .00123\,H)\,D - .19\,h.$$

When the exhaust nozzle is on the enter line, h is equal to zero and the last term disappears, and there remains,

$$d = (.246 + .00123)\,D.$$

For Tapered Stacks:

When the nozzle is below the center line of the boiler,

$$d = .25\,D + .16\,h.$$

When the nozzle is above the center line of the boiler,

$$d = .25\,D - .16\,h.$$

When the nozzle is on the center line of the boiler, h becomes zero, and

$$d = .25\,D.$$

In all of these equations, d is the diameter of the stack in inches. For tapered stack it is the least diameter or diameter of "choke." H is the height of stack in inches and for maximum efficiency should always be given as large a value as conditions will admit. D is the diameter of the front-end of the boiler in inches, and h the distance between center line of boiler and the top of the exhaust tip.

The fact is worthy of all emphasis that H should always be made as great as possible.

If D in the several equations is made equal to 54, the diameter of the front-end of the Purdue locomotive, the equations will give results identical with those which are assumed to represent the maximums obtained in the course of the experiments. How far they should be employed in the manner which has been indicated for engines having a boiler different in size can not, of course, be stated with certainty, though the undersigned is of the opinion that where the conditions surrounding stack and nozzle are similar, they may be depended upon to give satisfactory results for any diameter of front-end now in use or likely soon to come into use. What the conditions are which should be observed in the use of the equations is best shown by Figs. 101 and 102.

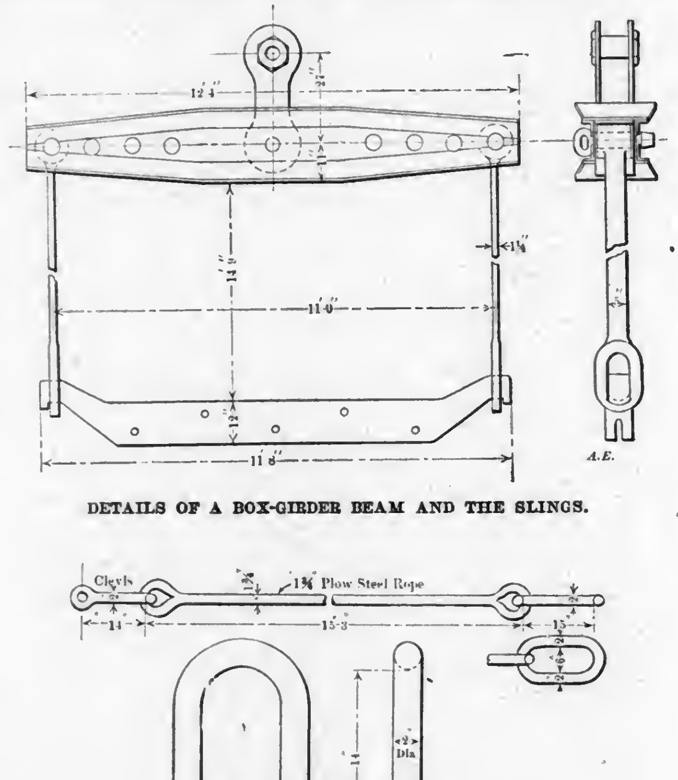
In this connection, also, it should be noted that it is not claimed that the plain stack and nozzle, as shown, will give better results than some other arrangement, but merely that when the plain stack and nozzle are used, the equations will give the best relation of diameter to height which is obtainable. It is this question only that the experiments were designed to cover. Whether, for example, as a general proposition, the application of draft or petticoat pipes will improve the draft, or whether they will affect the relation of height and diameter of stack as already established, can not be determined from the present work.

(*To be Continued.*)

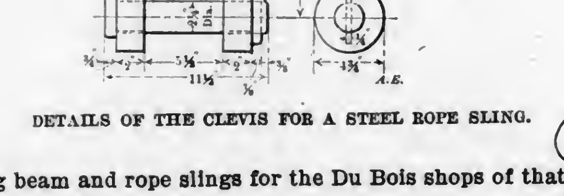
CRANE BEAM AND SLINGS.

For 50-Ton Traveling Cranes.

On looking up, in the technical papers, the subject of crane slings and beams for handling locomotives in erecting shops, a correspondent discovered a scarcity of information upon the subject and suggested the advisability of putting on record the construction of these details. Through the courtesy of Mr. Charles E. Turner and W. R. Maurer, of the Buffalo, Rochester & Pittsburg Railway, the accompanying engravings of the



DETAILS OF A BOX-GIRDER BEAM AND THE SLINGS.



DETAILS OF THE CLEVIS FOR A STEEL ROPE SLING.

lifting beam and rope slings for the Du Bois shops of that road are presented.

The sling is designed for a capacity of 50,000 lbs., and two were provided. The rope is of steel wire, the eye splices at the ends being made by the manufacturers of the rope. The lifting beam is a box girder, built up of angles and plates of the dimensions indicated. The Du Bois shops have longitudinal tracks.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

II.

Upon machine tools such as lathes, boring mills, etc., which handle work of varying diameter, the horse-power required is practically constant over wide ranges of speed. An ideal motor for such machines would be one in which the torque increases as the speed decreases. The torque of a motor is practically constant, however, and the horse-power varies directly as the speed.

If, for instance, a certain horse-power is required through a range of speed of 8 to 1, the motor, in order to furnish full power at its lowest speed, would be required to have a capacity which, at the highest speed, would be equal to eight times as much as the power required. This would, of course, be modified somewhat, if the speed range of the motor was increased by weakening the field. But as the field is weakened and the speed thus increased, the horse-power falls off rapidly. Thus, if the required range of speed is large, and the entire range is furnished through the motor, a large and bulky motor will be required, and, furthermore, it will not be very efficient at the lower speeds.

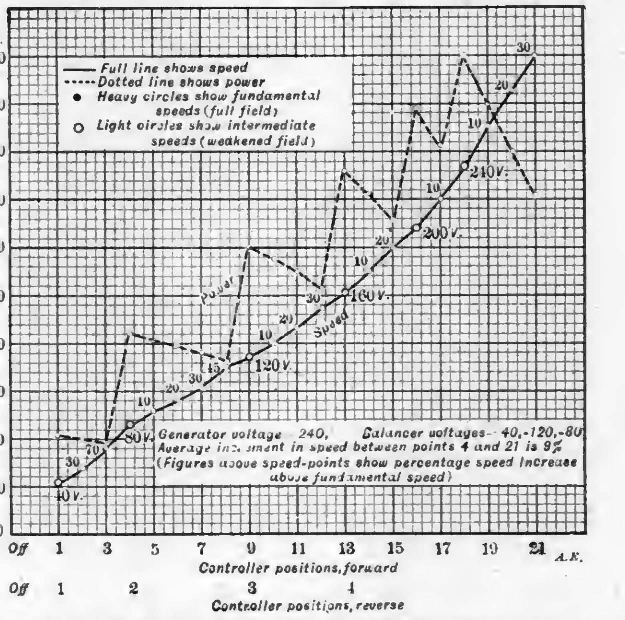


FIG. 1.—DIAGRAM SHOWING RELATION BETWEEN THE SPEED AND POWER OF A MOTOR USING THE M. F. 21 (FIELD WEAKENING) CONTROLLER.

With the Crocker-Wheeler Company's multiple voltage system, in cases where machine tools require a wide range of speed with a constant horse-power throughout, part of the range is taken by the motor and part by runs of gearing interposed between the motor and the machine. This system allows the use of a comparatively small motor whose average efficiency is greater than in the case cited above, since it need not be run at such comparatively low speeds.

A complete description of the Crocker-Wheeler four-wire multiple-voltage system will be found on pages 23 and 24 of the January, 1903, issue of this journal. For the McKees Rocks shops installation, the controller which is illustrated and described on page 24 of the January issue, and which is known as the M. A. 12 controller, will be used on part of the machines only. For certain machine tools, such as lathes, on which we wish to have a large number of speed changes, the M. F. 21 type of controller will be used.

The intermediate speeds between any two voltages are obtained in the M. A. 12 controller, by changing the armature resistance; this arrangement allows only one intermediate speed between any two voltages. The intermediate speeds with the M. F. 21 controller are obtained by weakening the field, and several intermediate speeds can be obtained between any two voltages. Furthermore, the intermediate speeds are more stable with the M. F. 21 controller, although the power at the intermediate speeds is reduced somewhat. Fig. 1 shows diagrammatically the relation between the speed and the power for the M. F. 21 controller, and Fig. 2 shows this relation for the M. A. 12 controller.

Let us now consider the case of the application of a motor to lathe No. 6. This is a 20-in. Reed lathe, the data for which, as belt driven, is shown on page 125 of the April issue of this journal. We wish to have a range of speed upon this tool of from 8 to 240 rev. per min. The class of work to be done on this lathe will not be very heavy and it was decided to fit it up for a capacity of taking a ¼-in. cut with a 1-32-in. feed on hard steel at a cutting speed of 50 ft. per minute.

The maximum horse-power required to do this work = 1-32 × ¼ × 50 × 12 × 1 × .7 = 3¼. (See formula on page 125 of the preceding article of this series.) Since the work is of a variable diameter, it will require 3¼, or say 3 horse-power, throughout the entire speed range. The question which naturally presents itself is: Can we make use of the gearing now on the lathe in connection with the application of the motor? The present back gear ratio is 10.7 to 1. Assume that the motor is connected so as to drive the main spindle at 240 revolutions per minute. Now, if the back gear is thrown in, the spindle speed will be 240 ÷ 10.7 = 22.4 revolutions per minute. In order to fill in the gap between 25 and 240 revolutions per minute the motor would be required to have a speed range of about 9.6 to 1. Referring to Fig. 1, it will be found that when the motor is running at 10.4 per cent. $\left(\frac{1}{9.6}\right)$ of its maximum speed, or the lowest speed, it will furnish about 20 per cent. of its rated power. Therefore, in order to furnish 3 horse-power throughout the range, a 15 horse-power motor would have to be used. A motor of this size would be very large and bulky for a 20-in. lathe and would not be very efficient at the lower speeds.

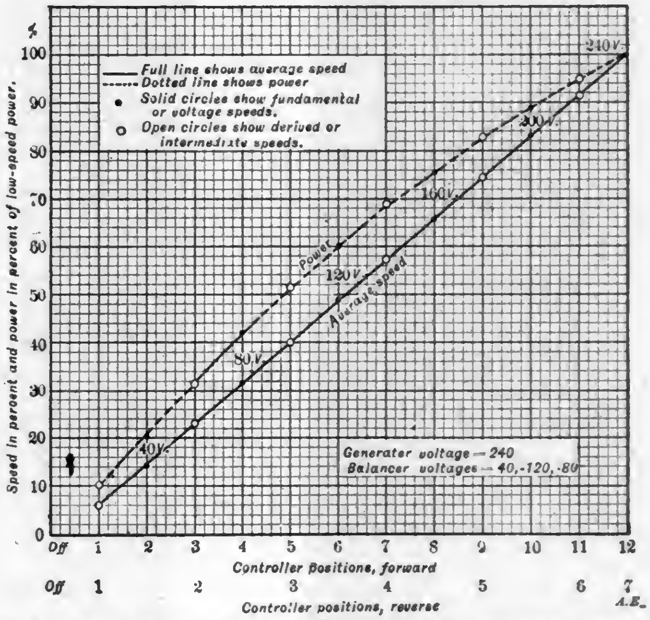


FIG. 2.—DIAGRAM SHOWING RELATION OF THE SPEED AND POWER OF A MOTOR USING THE M. A. 12 (ARMATURE RESISTANCE) CONTROLLER.

With the required power and range of speed, can we change the number of teeth in the present gears and use a smaller motor?

Two hundred and forty to 8 revolutions per minute is a range of 30 to 1. For such a range the motor and the run of gearing would each have to cover a range of speed of about 5.5 to 1. Referring again to Fig. 1, it will be found that the motor at 18 per cent. $\left(\frac{1}{5.5}\right)$ of its maximum speed, furnishes prac-

tically the same percentage of power as in the case considered above, and so we are really not much better off.

Suppose then we add another run of gears. The motor and each run of gears would be required to have a range equal to the cube root of 30, or about 3.108 to 1. The spindle speeds would run thus:

	Maximum.	Minimum.
First run	240	77.3
Second run	77.3	24.9
Third run	24.9	8.0

It would be just as well, however, if there were a jump of speed between the different runs of gearing equal to the 10 per cent. speed increments furnished by the controller. Reduce the speed range of the motor 10 per cent., or from 3.108 to 1 down to 2.79 to 1, and the spindle speeds will run thus:

	Maximum.	Minimum.
First run	240	86
Second run	77.3	27.8
Third run	24.9	8.93

The lower speed limit is increased somewhat, but this can easily be remedied by changing the ratios slightly. The motor could, of course, be run at a still lower speed, but at reduced power.

Referring again to Fig. 1, it will be found that when the motor is running at 36 per cent. $\left(\frac{1}{2.79}\right)$, of its maximum speed, it furnishes 60 per cent. of its total power. Therefore, in order to have 3 horse-power available throughout the range, a 5 horse-power motor will have to be used. At controller points 10, 11 and 12, it will run a little below 3 horse-power, but the motor will run at full power at these points a small part of the time, only, and it can easily take care of the slight overload.

A chart similar to the one shown in Fig 3 will be found very

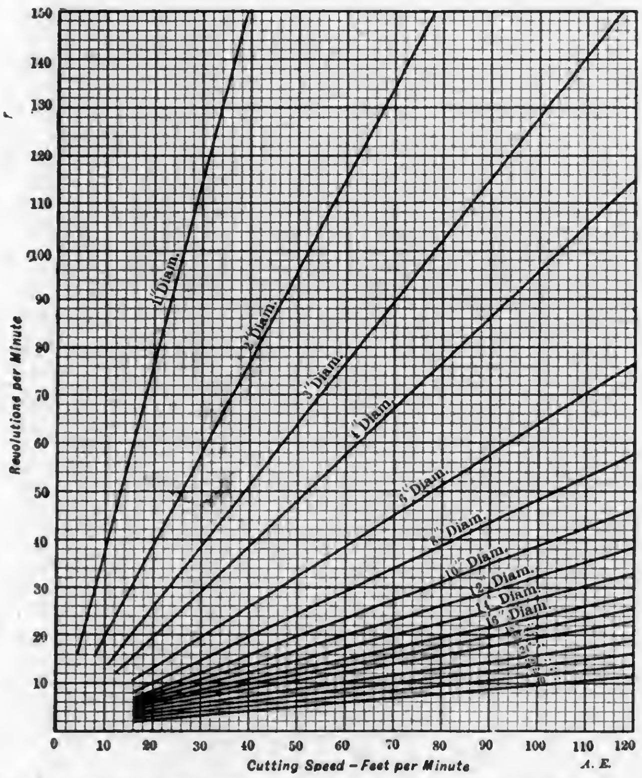


FIG. 3.—CHART INDICATING SPINDLE SPEEDS NECESSARY FOR DESIRED CUTTING SPEEDS WITH WORK OF VARYING DIAMETERS.

useful in determining the spindle speeds for all cutting speeds with work of various diameters.

When two runs of gearing are used in connection with the motor, the arrangement shown in Fig. 4 is very convenient. X and Y, in the engraving, represent a double and single jaw clutch respectively. Gears F, C, B and H run loose on the main spindle. B is keyed to an extension of gear C. When X is thrown to the left, the motor drives the main spindle direct. When X is in the center and Y is thrown to the right, the reduction is through $\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F}$. When Y is out and X is thrown to the right, the drive is through $\frac{A}{B} \times \frac{C}{D} \times \frac{G}{H}$.

Figs. 5 and 6 show in detail the double jaw clutch used. These clutches are made of cast steel and have only three jaws, which are large and substantial. The corners of the teeth are beveled off and the teeth have 1-16-in. play in the cavities into which they fit. This allows the clutch to be thrown in while the lathe is slowing up and before it has come to a full stop.

With the arrangement shown in Fig. 4, all the gears will be running all the time the lathe is in operation. The idle gears will, however, run at a slow speed and the greater part of the time only one pair will run idle since the lathe will work on one of the two slower runs most of the time. The wear on the gears while running idle will not amount to much. This slight disadvantage can be overlooked when we consider the

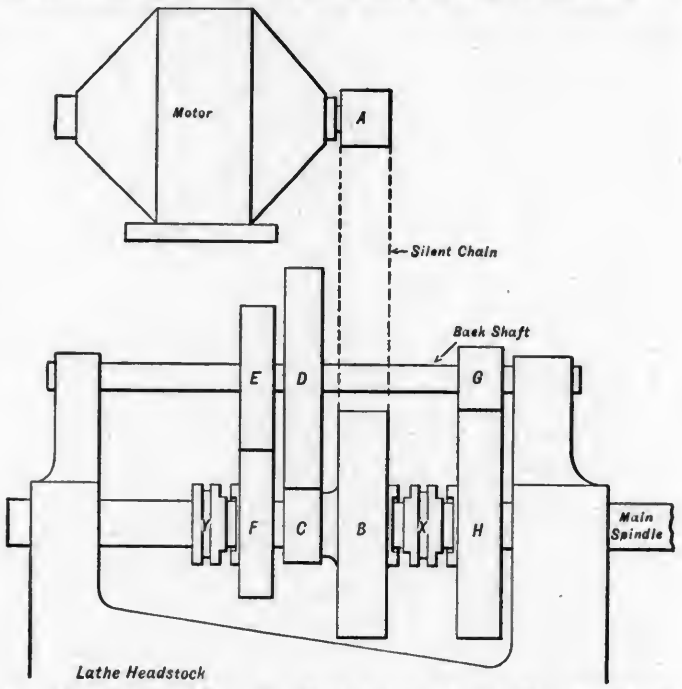


FIG. 4.—ARRANGEMENT OF DRIVE WITH TWO RUNS OF GEARING GIVING THREE SPINDLE SPEEDS FOR EVERY MOTOR SPEED.

ease with which the change can be made from one run of gears to either of the others.

If, instead of clutches, the gears themselves were to be shifted on the shaft, it would be necessary to bring the lathe to a dead stop and then move the machine slightly backward or forward in order to get the teeth to mesh.

In place of bronze bushings for the cast steel parts which run loose on the shaft, babbitt metal will be used as shown in the drawing of the jaw clutch in Fig. 6. This is not as good practice, but in several cases we found that it would be very inconvenient to allow enough room to take in a bushing.

Fig. 7 shows the motor attached to the lathe. The brackets which support the motor are cast with chipping strips where they fit against the headstock. The motor is connected to the main spindle as indicated by a 2¼-in. Morse silent chain. This is easily applied and furnishes a very convenient method of making the speed reduction.

With a vertical chain-drive it is necessary to have some means of taking up the slack, as the chain wears. We expect to do this by placing shims under the motor feet. The same result may be accomplished by fitting a set screw with a lock nut into the motor bracket, with the point of the screw pressing upward against the motor foot, so as to adjust the height thereof. The motor would be held to the bracket by through bolts as before. With a horizontal drive the weight of the chain itself, of course, provides for the slack.

With the use of the silent chain it is advisable to have an uneven number of teeth in both chain sprockets in order to

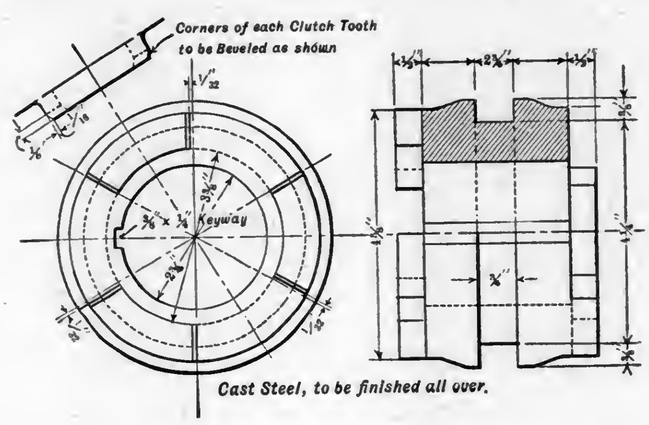


FIG. 5.—DETAILS OF THE DOUBLE JAW STEEL CLUTCH.

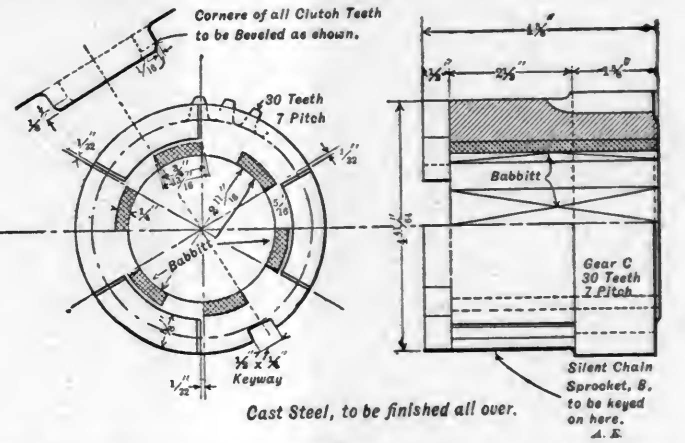


FIG. 6.—DETAILS OF THE SINGLE-JAW CLUTCH, TO CARRY SILENT CHAIN SPROCKET AND GEAR—C.

keep the wear on the sprocket teeth even. It is advisable with a motor drive to have an uneven reduction from the motor in any case, whether it is made by silent chain or gears; otherwise, if the work is regularly intermittent (the cut on a piece in a lathe, for instance, might be light except at one part of the revolution where it might be very heavy), an excessive torque may be necessary at one point of the revolution, and if it comes on the same commutator bar each time it will cause a bad sparking and eventually ruin that commutator bar.

In designing new gears and in checking over the strength of such old ones as we found it possible to use, the formula, W = s p f y, devised by Wilfred Lewis (see Kent's Pocket Book, page 901), was used. Comparing this with the practice followed by some of the tool builders we found that it gave a rather low value for the strength, and, therefore, in several cases where the load on the gears was steady we used somewhat higher values, for the safe working strength for different speeds, than those given in connection with the formula.

The sizes of keys were determined by reference to table on page 976 of Kent's Pocket Book, entitled, "Size of Keys for Machine Tools." The sizes for sliding feathers were determined from Table III. on page 977 of Kent's Pocket Book.

In order to prevent a careless workman from throwing in the two opposing clutches at the same time an interlocking device was devised by our chief draughtsman, Mr. W. P. Richardson. This mechanism is illustrated in Figs. 7 and 8.

A and B are the handles of the two levers which operate the

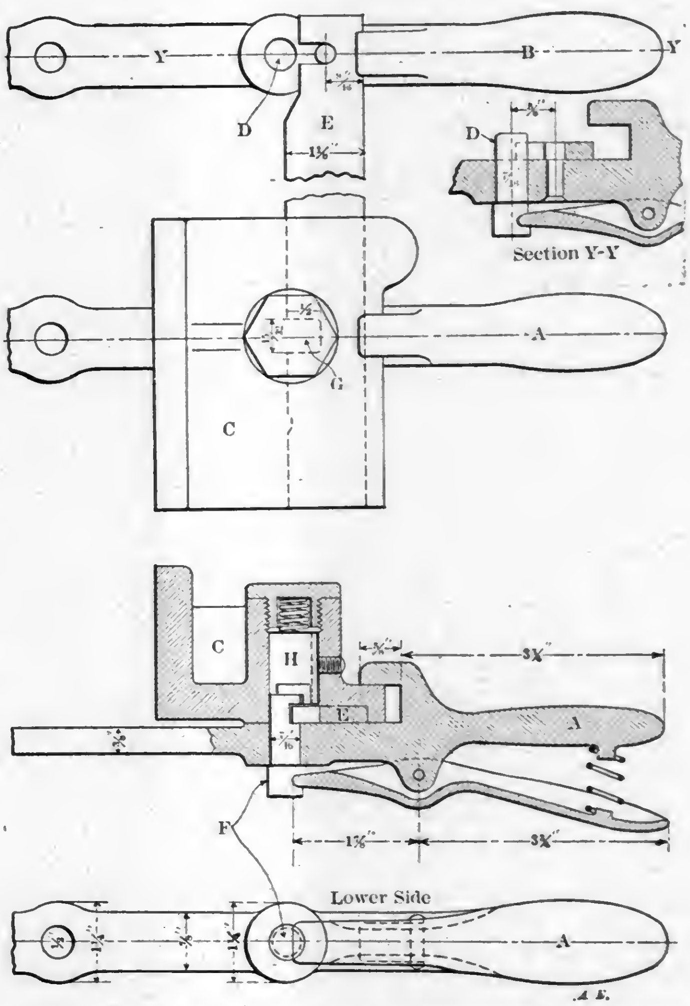


FIG. 8.—DETAILS OF CLUTCH HANDLE INTERLOCKING MECHANISM.

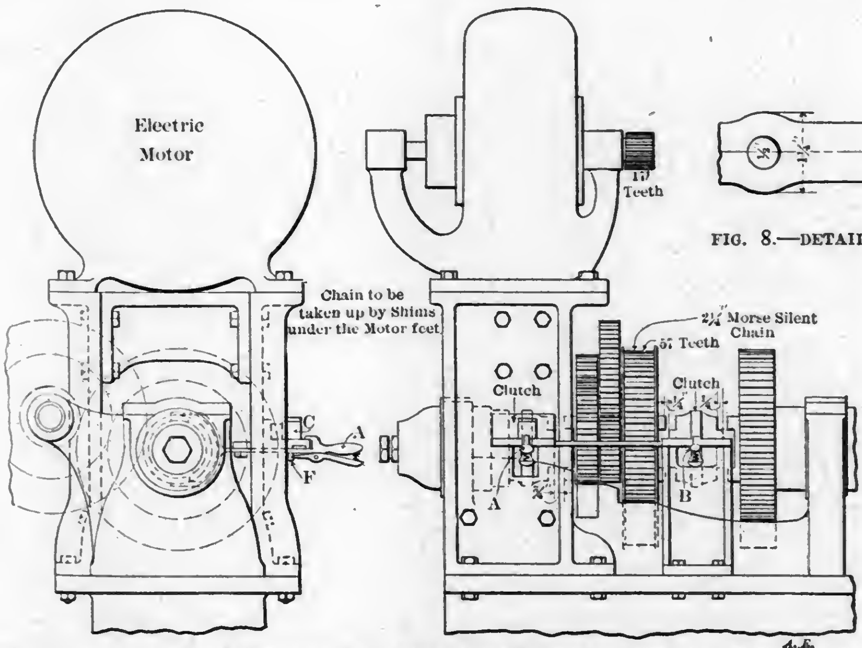


FIG. 7.—DETAILS OF THE APPLICATION OF THE MOTOR TO THE LATHE, SHOWING ARRANGEMENT OF INTERLOCKING CLUTCH HANDLES.

clutches on the main spindle of the lathe. C is the latch bracket for lever A, and carries the locking mechanism. The latch bracket for lever B is a plain bracket (not shown), merely provided with holes for engaging the latch pin D.

E is a latch bar pinned to lever B, and slides freely in a groove of the bracket C when the lever A is in its mid position, and the clutch it operates is thus disengaged.

Any side movement of the lever B slides the bar E so that it engages in the slot in latch pin F and thus locks lever A; the latter remains locked until the lever B is

returned to its central position and the clutch operated by it is thus disengaged.

When B is in its central position, the bar, E, is moved along so that the latch pin, F, may be drawn past it through the slot, G, and the lever, A, thus unlocked. But, in so doing, the stop pin, H, no longer held up by the latch pin, F, has been forced down by the spring above it, into slot, G, and the bar, E, is securely locked; this in turn locks lever, B, in its central position with its clutch out.

(To be continued.)

STEEL CARS ON THE BESSEMER & LAKE ERIE RAILROAD.

A complete record of steel car construction in this country would be valuable and interesting. Its value would be greatest in showing that some of the earliest designers in this field worked out ideas the importance of which is only now admitted or recognized. The record would reveal a number of backward steps and it would impress the importance of knowing what has been done in order to retain continuity of progress.

By special request for a record of the designs which have impressed themselves upon the construction of this equipment, drawings and information have been secured showing the development upon the Bessemer & Lake Erie Railroad, the pioneer in this country in the use of steel cars on a large scale.

THE FOX STEEL FLAT CAR—1894.

The credit belongs to Mr. Charles L. Taylor, who has been connected with the Carnegie interests for more than twenty years and is now chairman of the Carnegie Relief Fund. While traveling in Europe early in 1894, Mr. Taylor became thoroughly impressed with the successful use of steel in car construction on the Continent and returned to this country firmly convinced that the time for large capacity steel cars had arrived. He had been closely identified with the first manufacture of soft Bessemer steel in this country as superintendent of the Homestead Steel Works from 1882 to 1886. During this period the transition from iron to steel in the manufacture of ship plates, bridge and structural material had been most marked, these works having been pioneers in this development.

The Havre de Grace bridge of the Baltimore & Ohio Railroad was the first Bessemer steel structure in this country, and it converted Rear-Admiral Robley D. Evans to this material. He was the inspector of the steel for that structure and had much to do with introducing soft steel plate and developing its manufacture for vessels of the navy. With the growth of the demand the manufacturers were prepared for extending the manufacture, and thus the shipbuilding interests and others using soft Bessemer steel had an important influence on the steel-car situation by rendering the steel car possible commercially.

In 1894 the first step in the large scale development of the steel car was taken. It was not taken by a railroad but by a steel company, and since that time the use of steel in this construction has increased with marvelous rapidity. During the three years from 1900 to 1902, inclusive, the Carnegie Steel Company alone has furnished about 1,000,000 tons of steel for car construction, over 400,000 tons having been shipped during the year 1902. Other companies have added their quota, but these figures serve to show the growth of the industry. Up to January 1, 1903, the total output of the six largest manufacturers of steel cars has been 96,021 all-steel cars, not including cars with steel underframes.

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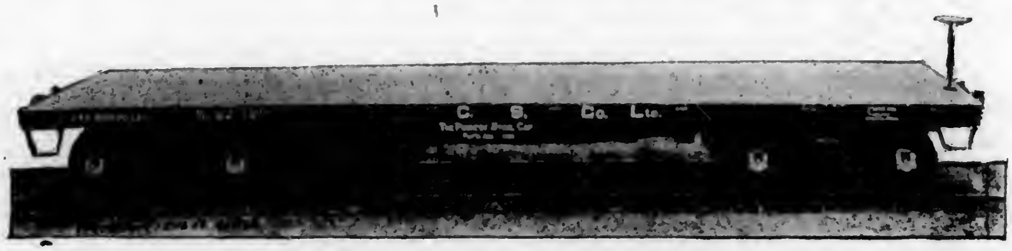
Length over end sills	34 ft. 1 in.
Length between truck centers	24 ft.
Wheel base of trucks	5 ft. 2 ins.
Width over decking	8 ft. 7½ ins.
Width over stake pockets	9 ft. 5 ins.
Height of deck from top of rails	3 ft. 11½ ins.
Capacity	80,000 lbs.
Weight of No. 1002	26,220 lbs.
Weight of No. 1007	25,150 lbs.

PENNOCK FLAT CARS, 1895.

An outcome of numerous interviews between Mr. Charles L. Taylor and Mr. Willard Pennock, of Pennock Bros., Minerva Car Works, Minerva, Ohio, was the construction of a Pennock all-steel flat car purchased by the Carnegie Steel Company in June, 1895. This car was rated with a capacity of 60,000 lbs., and was tested at Pittsburg in July, 1895, with a load of 118,000 lbs. of steel billets, giving a deflection at the center of ⅝ in. This car was constructed of fish-bellied steel channels placed side by side, the webs forming the floor and the flanges being secured together by rods extending across the car, forming longitudinal ribs extending the full length of the car. The construction is illustrated by the accompanying engraving. This car weighed 22,620 lbs. Its center was reinforced by a 12-in. I beam split in the center, each half being used as a center



THE PENNOCK STEEL FLAT CAR—1895.

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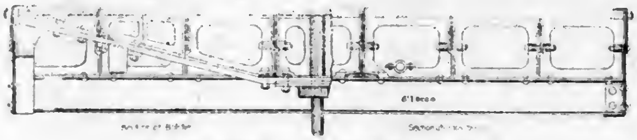
A wooden hopper coal car, designed and built by the Pennsylvania Railroad in 1895, has exerted a strong influence on



CROSS SECTION OF THE PENNOCK CAR.

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KEYSTONE HOPPER CARS, 1896.

Capacity	100,000 lbs.
Weight	39,950 lbs.
Length over end sills	30 ft.
Length between truck centers	19 ft. 10 ins.
Wheel base of trucks	5 ft. 2 ins.
Width over end sills	9 ft. 5½ ins.
Width, inside	8 ft. 10½ ins.
Length of body, inside	28 ft.
Depth of sides, over sills	5 ft. ½ in.
Height, top of rail to top of sides	8 ft. 9 ins.
Extreme width over grab irons	10 ft. ⅝ ins.

These two cars were mounted on Fox pressed steel trucks and it is specially noteworthy that they were equipped with the Westinghouse friction draft gear, with Carnegie nickel axles and with the hopper door opening devices devised by Mr. G. L. Potter, now general manager of the Baltimore & Ohio Railroad. The builders tested them with a load of 125,000 lbs. of wet sand and found no important deflections. It was stated at that time that their weight could be reduced to 35,000 lbs. with perfect safety. After this test the capacity was stenciled at 100,000 lbs.

These cars had 15-in. I beam center sills (41 lbs. per ft.) The side sills were 12-in. 20-lb. channels, concealed under the side plates. The end sills were 15-in. 33-lb. channels with ¼ by 12 in. plates riveted to their upper flanges. The body bolsters were 12-in. 20-lb. channels with 5-16 by 14 in. plates secured to their upper flanges; as a center transom a 12-in. 32-lb. I beam was used. The center sills were made continuous from end to end. It is interesting to notice that the underframe is

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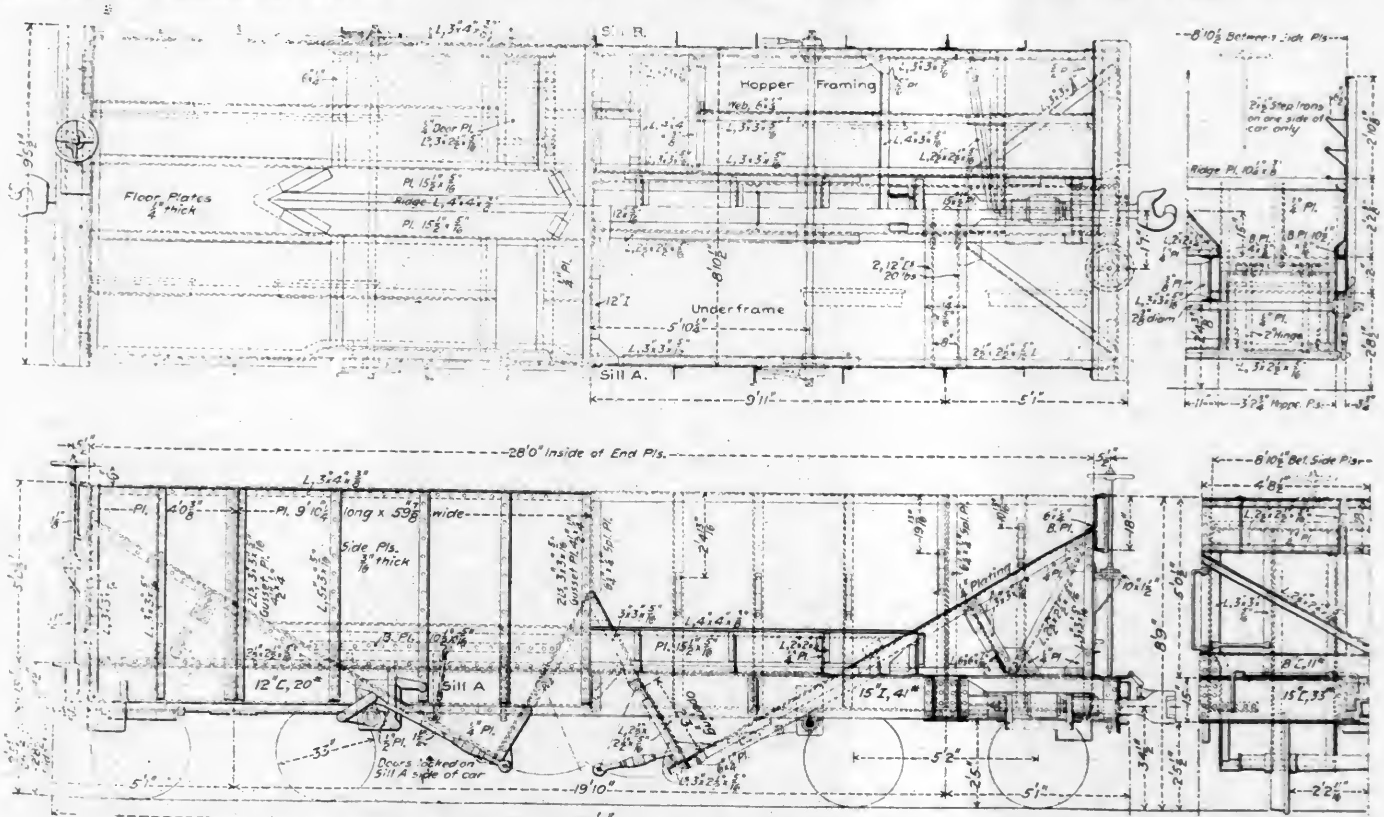

PLAN, AND SIDE AND SECTIONAL ELEVATIONS OF THE STRUCTURAL STEEL CAR BUILT BY THE KEYSTONE BRIDGE WORKS

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Fox Steel Flat Cars, 1894.

Length over end sills	34 ft. 1 in
Length between truck centers	21 ft
Wheel base of trucks	5 ft. 2 ins.
Width over decking	8 ft. 7½ ins.
Width over stake pockets	9 ft. 5 ins.
Height of deck from top of rails	3 ft. 11½ ins.
Capacity	80,000 lbs.
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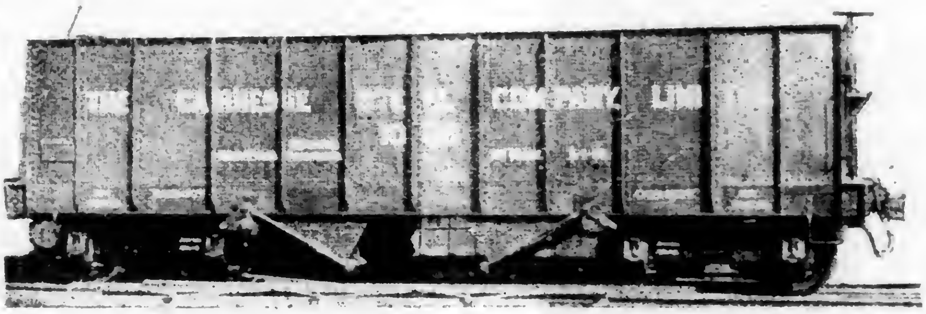

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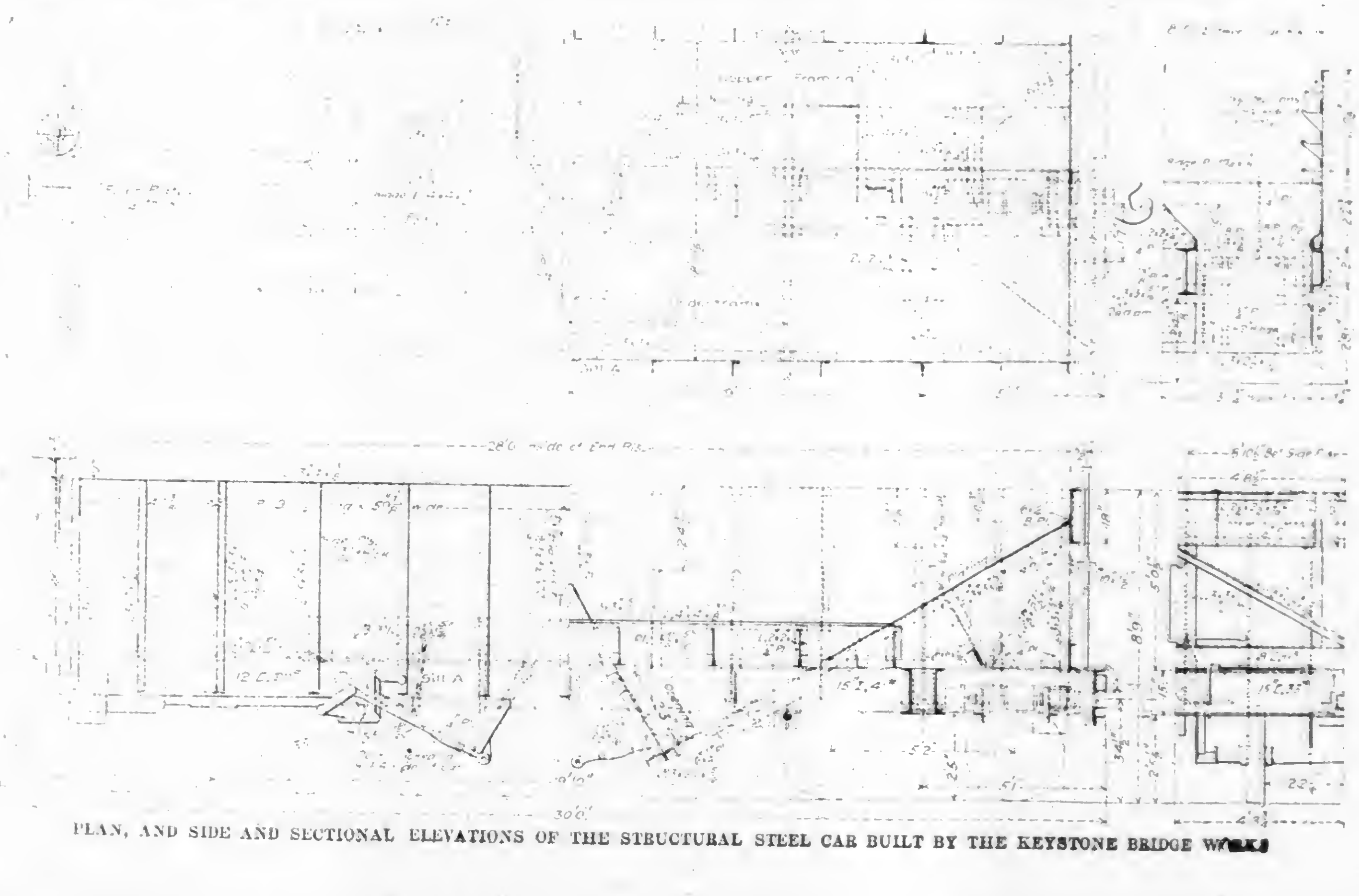

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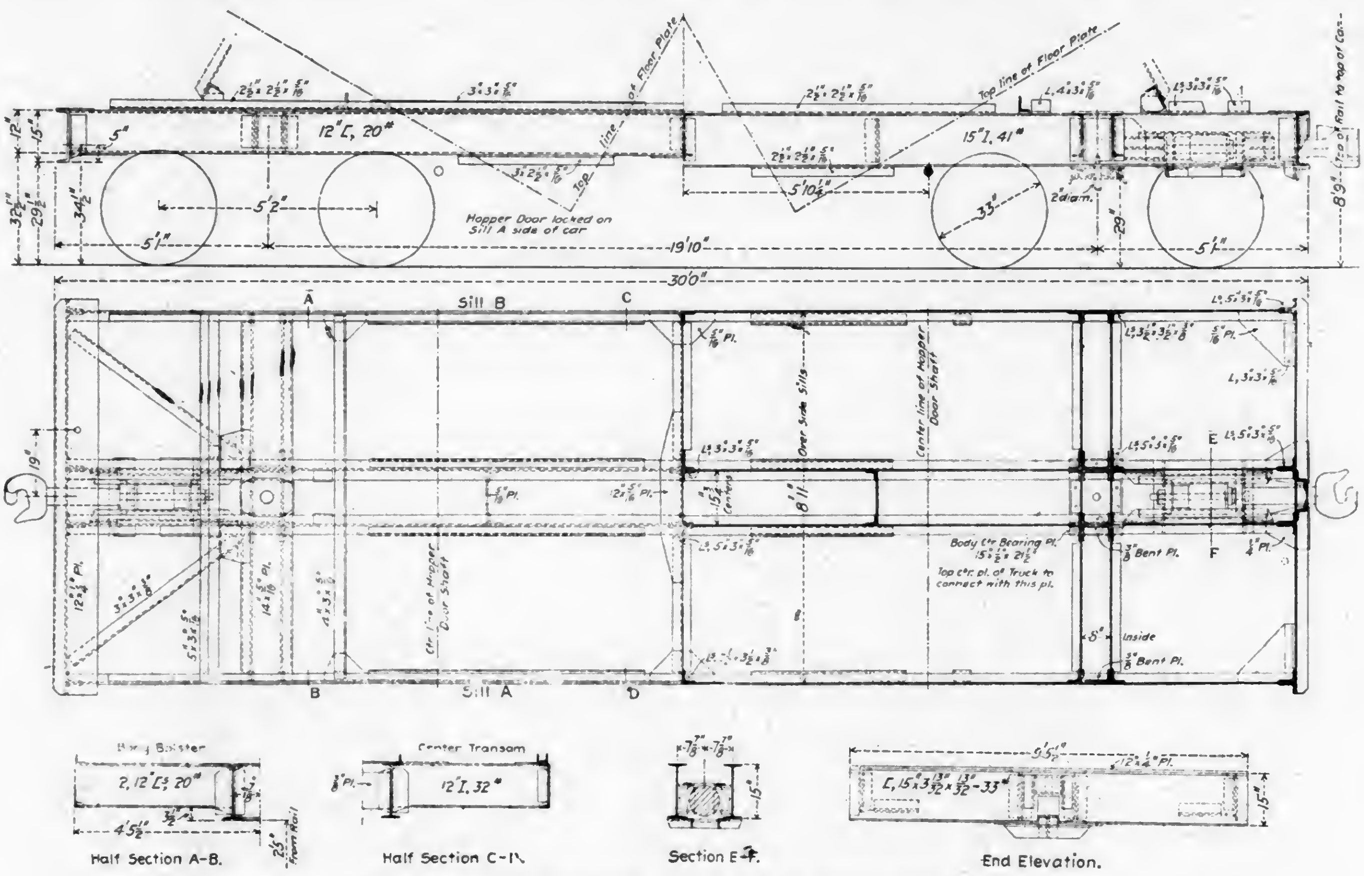


DETAILS OF THE KEYSTONE BRIDGE WORKS STRUCTURAL CAR.

a structure by itself and that the hopper construction was built upon it. The drawings of these cars are dated January 22 and January 31, 1896.

The exhibits of these cars by the Carnegie Company at the Saratoga convention in 1896 elicited the interest not only of car builders but of operating officers throughout the country. The claims for the steel car being: Lightness, durability and strength; greater proportion of live to dead weight; longer life; reduced cost of maintenance; less liability to damage and greater salvage value. Experience has verified these claims and the present state of the steel car industry gives proof of the sagacity of the pioneers.

EARLIEST SCHOEN CARS.

On March 26, 1897, the first contract for building steel cars in this country was signed by the Pittsburg, Bessemer & Lake Erie and the Schoen Pressed Steel Company. Up to this time the Schoen Company had confined its attention to small parts of pressed steel. The execution of this contract for 1,000 cars rendered possible the enlargement of the Schoen Company, which has exerted so powerful an influence upon steel car building and has earned the title for the credit for the subsequent development of this industry.

The contract called for the construction of 1,000 hopper cars. Four hundred were built of structural shapes and 600 were from the original design of pressed steel construction by Mr. Charles T. Schoen. This contract was the beginning of the development of large capacity steel cars on a large scale and the pressed steel hopper car has closely followed the first design in cars built since that time. The drawings of the structural car bear the date of January 22, 1897, this design having been developed by Mr. Taylor and Mr. Hardie of the Carnegie Company. The drawing of the Schoen car bears the date of June 20, 1898. Both designs employed the Westinghouse friction draft gear and Carnegie nickel steel axles, having about 3 per cent. of nickel. These axles have given most gratifying results in continuous heavy service. We are informed that only two out of the 4,000 axles in this order have broken in a service of six years. In order to test the construction and utility of various steel trucks these cars were equipped as follows:

STEEL TRUCKS FOR THE FIRST 1,000 STEEL CARS.

Number of Cars.	Design.	Type of Truck.
200	Schoen	Schoen
395	Schoen	Vogt
5	Schoen	Buckeye
600		
100	Carnegie	Schoen
200	Carnegie	Fox
50	Carnegie	Kindl
30	Carnegie	Cloud
10	Carnegie	Vogt
10	Carnegie	Goltra
400		

FIRST CONTRACT FOR STEEL CARS, 1897.

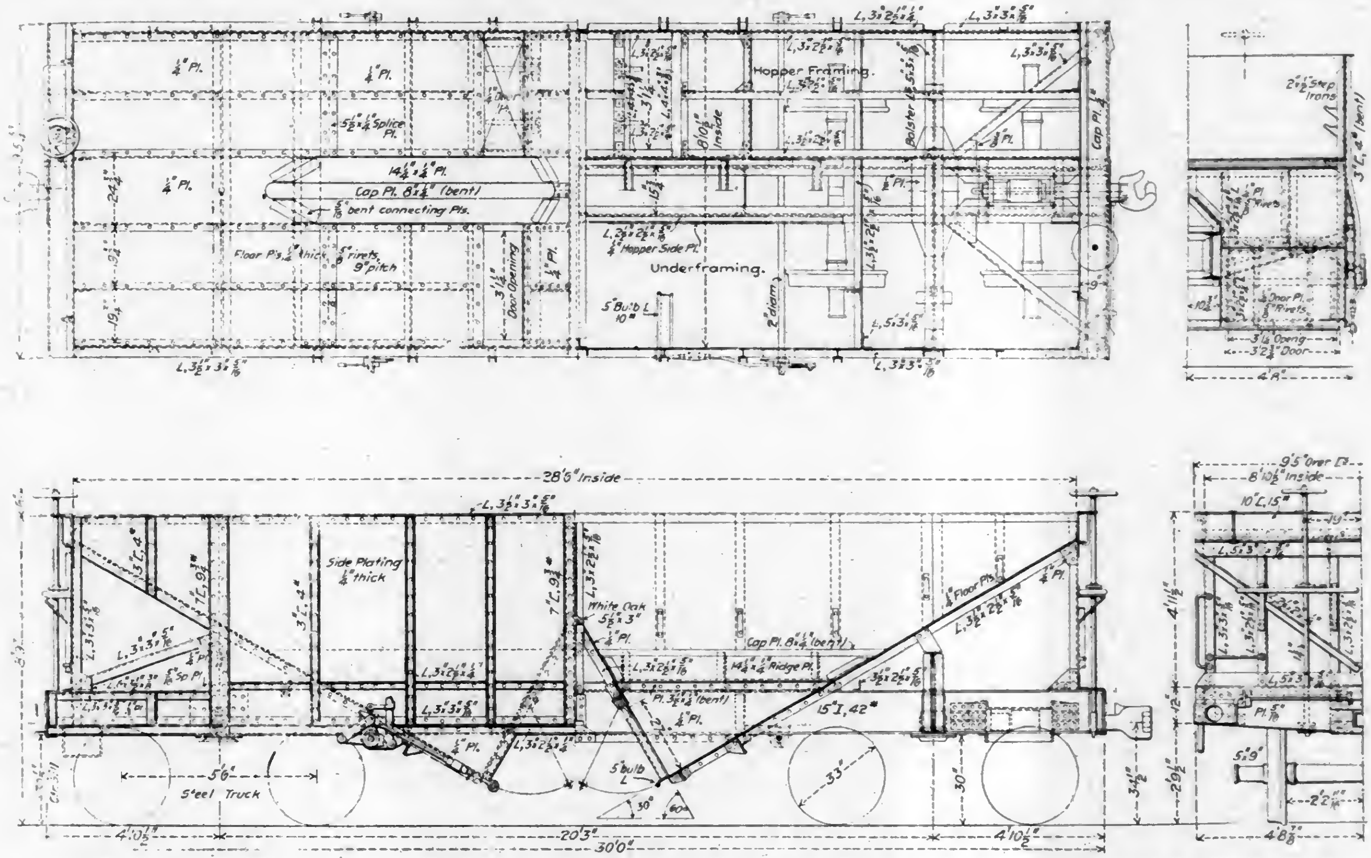
400 CARS, CARNEGIE DESIGN, STRUCTURAL SHAPES.

Capacity	100,000 lbs.
Weight	37,150 lbs.
Length over end sills	30 ft.
Length between truck centers	20 ft. 3 ins.
Wheel base of trucks	5 ft. 6 ins.
Width over end sills	9 ft. 5¾ ins.
Width, inside	8 ft. 10½ ins.
Length of body, inside	28 ft. 6 ins.
Depth of sides over sills	5 ft. 11½ ins.
Height, top of rail to top of sides	8 ft. 9 ins.

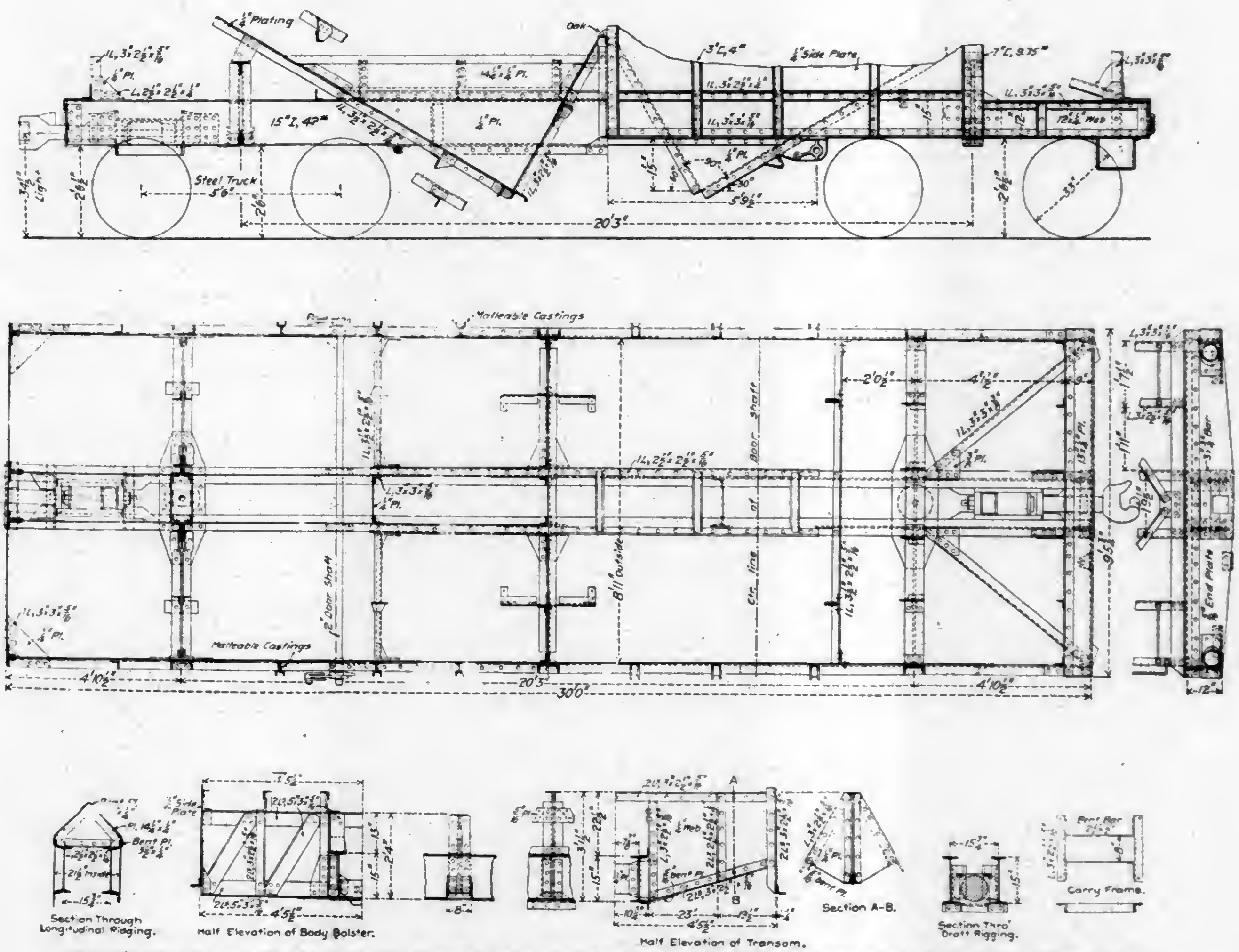
The underframe of this car was based upon 15-in. I beam center sills and had no side sills. Instead of using side sills of structural shapes, the lower portions of the side plates were reinforced by longitudinal angles, as shown in the engravings. This resulted in a construction giving the appearance of 15-in. side sills between the bolsters and 12-in. members from the bolsters to the end sills. This design employed latticed bolsters of the unusual depth of 2 ft. 4 ins., and at the center of the car was a transom of plates and angles. In this car the sides were depended upon to assist in carrying the load, and many designers of more recent date have forgotten this fact.

600 CARS, SCHOEN PRESSED STEEL DESIGN.

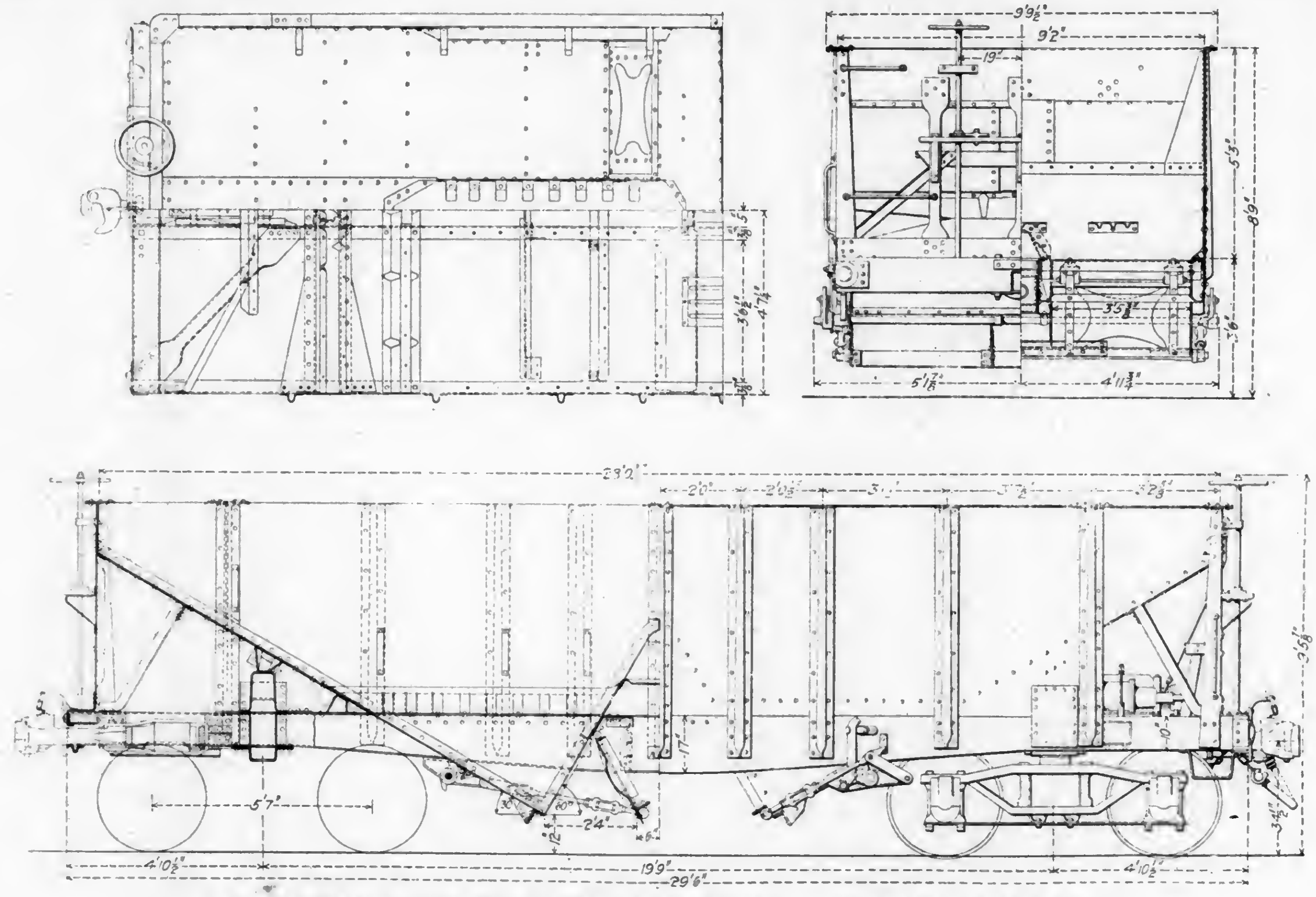
Capacity	100,000 lbs.
Weight	34,350 lbs.
Length over end sills	29 ft. 6 ins.
Length between truck centers	19 ft. 9 ins.
Wheel base of trucks	5 ft. 7 ins.
Width, over stakes	9 ft. 8 ins.
Width, inside	9 ft. 2 ins.
Length, inside	28 ft. ¼ in.
Height, top of rail to top of sides	8 ft. 9 ins.



FIRST STRUCTURAL HOPPER CARS BUILT FOR THE PITTSBURG, BESSEMER & LAKE ERIE R. R. BY THE SCHOEN PRESSED STEEL CAR CO., CARNEGIE DESIGN—1897.



DETAILS OF THE ABOVE STRUCTURAL HOPPER CAR, CARNEGIE DESIGN, BUILT BY THE SCHOEN PRESSED STEEL CAR CO.



FIRST SCHOEN PRESSED STEEL HOPPER CARS FOR PITTSBURG, BESSEMER & LAKE ERIE R. R.

This car has the Schoen fish-bellied center and side sills, which are 10 ins. deep at the ends and 17 ins. at the center. The body bolsters are pressed, of trough section, and the construction is in general similar to that which has become so familiar. The trucks shown in this engraving are the Vogt type, with pressed steel arch bars.

ORIGINAL SCHOEN GONDOLA CAR, 1898.

This car was the original of a large number of gondolas built for the Pittsburg, Bessemer & Lake Erie by the Schoen Company. In January, 1903, this road had in service 3,690 hopper and 2,100 gondola cars, all of steel construction, and 1,000 steel gondolas are now being built for the Carnegie interests for use on the Union Railway (of Pittsburg.)

ORIGINAL SCHOEN STEEL GONDOLA CAR, 1898.

Capacity	80,000 lbs.
Weight	29,900 lbs.
Length over end sills	35 ft. 6 ins.
Length between truck centers	24 ft.
Wheel base of trucks	5 ft. 7 ins.
Width over stakes	9 ft. 9½ ins.
Width inside	9 ft. 2 ins.
Length inside	34 ft.
Height of top from top of rail	7 ft. 4¼ ins.
Height of sides, inside	3 ft. 10 ins.

The vital point in the net cost of transportation being directly dependent on the relation of live to dead load, in which cost is involved, economy in tractive resistance; fuel and steam consumption; reduction in train crew forces; reduction in transportation mileage; fewer number of cars

Type of Car.	Individual Capacity (Lbs.).	Individual Dead Weight (Lbs.).	Number of Cars in Train.	Total Train Length (Ft.).	Total Dead Weight Train (Pounds).	Total Live Weight Train (Pounds).	Total Load Hauled (Lbs.).	Ratio of Paying Freight to Total Load Hauled (Per Cent.).
Pennsylvania Railroad wood gondola	28,000	18,500	137	4,345	2,534,500	3,850,000	6,384,500	60.30
Pennsylvania Railroad wood gondola	40,000	24,800	96	3,235	2,380,800	3,850,000	6,230,800	61.80
Pennsylvania Railroad wood gondola	40,000	20,700	96	2,400	1,987,200	3,850,000	5,837,200	65.95
Pennsylvania Railroad wood gondola	40,000	21,000	96	3,600	2,016,000	3,850,000	5,866,000	65.63
Chicago & Northwestern wood hopper	40,000	23,800	96	2,210	2,284,800	3,850,000	6,134,800	62.75
Philadelphia & Reading wood gondola	50,000	23,745	77	2.810	1,828,365	3,850,000	5,678,365	67.81
Southern wood gondola	60,000	26,100	64	2,340	1,670,400	3,850,000	5,520,400	69.74
Baltimore & Ohio wood hopper	60,000	29,700	64	1,860	1,900,800	3,850,000	5,750,800	66.95
Lake Shore & Michigan Southern wood drop-bottom	60,000	27,150	64	2,240	1,737,600	3,850,000	5,587,600	68.91
Norfolk & Western wood drop-bottom	60,000	27,400	64	2,340	1,753,600	3,850,000	5,603,600	68.71
New York, Ontario & Western wood hopper	60,000	25,150	64	1,865	1,609,600	3,850,000	5,459,600	70.52
Individual wood hopper	60,000	23,400	64	1,730	1,497,600	3,850,000	5,347,600	71.99
Baltimore & Ohio lines wood hopper	60,000	30,800	64	2,340	1,971,200	3,850,000	5,821,200	66.13
Erie wood hopper	70,000	33,300	55	2,090	1,831,500	3,850,000	5,681,500	67.77
Hocking Valley wood hopper	80,000	33,600	48	1,800	1,612,800	3,850,000	5,462,800	70.47
Lake Shore & Michigan Southern wood hopper	80,000	36,500	48	1,590	1,752,000	3,850,000	5,602,000	68.73
Pennsylvania Gg. wood hopper	80,000	35,200	48	1,500	1,689,600	3,850,000	5,539,600	69.50
Bessemer & Lake Erie steel hopper	110,000	36,300	85	1,070	1,270,500	3,850,000	5,120,500	75.19
Algoma Central steel hopper	110,000	29,200	35	840	1,022,000	3,850,000	4,872,000	79.03
Duluth & Iron Range steel hopper		29,000	32	755	928,000	3,850,000	4,778,000	80.58

Note.—The cars represented in the table were taken at random and represent a fair average of those in service under their respective classes. Those of the Algoma Central and Duluth & Iron Range represent the most compact modern types of steel hopper cars, but on account of the extremely short wheel base, concentrating the load on a short span, the limit of their operations must be confined to the roads for which they were constructed.

to handle and repair; and reduction in equipment of cars, wheels, axles and other accessories connected therewith, and so on down to a saving in track equipment, all of which advantages were apparent during the early stages of the development of the steel car, is shown by an increase of about 20 per cent. in the ratio of paying freight to total load hauled. The tabulation presented above details this increase.

Assuming a standard ore train on the Bessemer & Lake Erie Railroad made up of 35 steel hopper cars as a basis, the total load hauled being 1,925 net tons, or an average of 55 net tons (110,000 lbs.) per car, the advantages of the steel car over the wooden type are quite clearly defined.

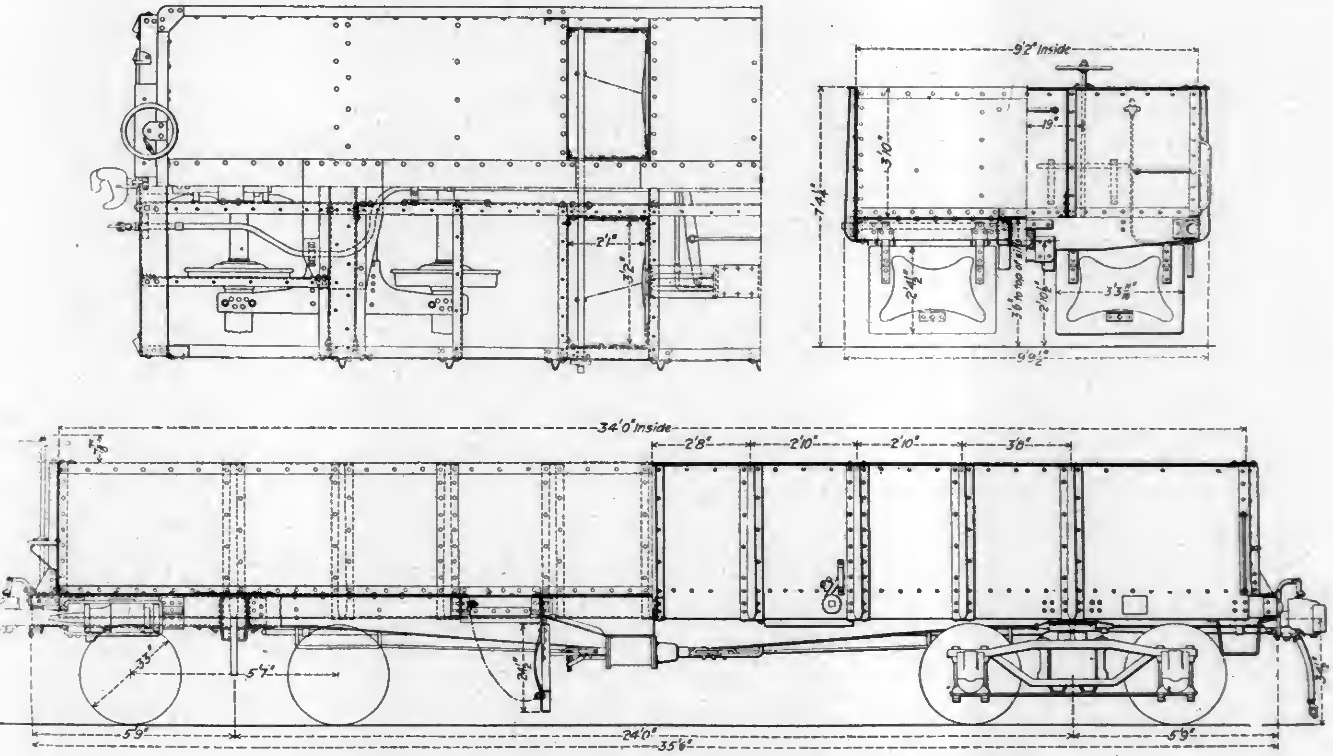
Note.—The cars represented in the above table were taken at random and represent a fair average of those in service under their respective classes. Those of the Algoma Central and Duluth & Iron Range represent the most compact modern types of steel hopper cars, but on account of the extremely short wheel base, concentrating the load on a short span, the limit of their operations must be confined to the roads for which they were constructed.

We are indebted to Mr. E. H. Utley, general manager of the Bessemer & Lake Erie Railroad, for these valuable drawings, and to Mr. Charles L. Taylor for assistance in securing information.

The study of this subject in collecting this information has led to similar treatment of the problem on another railroad, which will be presented in another issue.

Inasmuch as the amount of current required for exciting the field magnets of an electric motor is only a small fraction of the total current taken by the motor, the efficiency of the method of varying speed by field control is very high and is practically the same at minimum and maximum speeds; the relatively small amount of current handled permits of the use of a very small controller and renders it very easy to arrange for a large number of different running speeds.

A test of a 300 h. p. horizontal engine in England with superheated steam, produced under the improved Schmidt system of superheating, has shown a figure of 9 lbs. of steam per horse power hour. The temperature at the superheater was 800 deg. F.



SCHOEN GONDOLA CAR FOR THE PITTSBURGH, BESSEMER & LAKE ERIE RAILROAD.

DRIVING PLANERS.

The Variable Power Required, as Revealed by the Individual Motor Drive.

BY J. C. STEEN.

If the individual driving of planers by electric motors had no other advantage than that of enabling its performance to be investigated from the standpoint of power consumed throughout the complete cycle of its movements, that alone would be of great value. In a certain large and well-equipped machine shop there is an individual motor-driven planer which presents in an interesting manner the characteristic features of the driving of an ordinary planer.

The motor which drives the planer is belted to the countershaft in the usual manner and operates at a constant speed. The planer, which was a 60-in. x 18-ft. machine, was made by a prominent machine tool builder, has four cutting heads and is spur-gear driven. An ammeter was permanently connected in the motor supply circuit and showed at all times the quantity of energy being used. At the time of the observations noted below, the machine was at work planing a block of forged steel about 20-ins. long, one tool cutting only. The capacity of the ammeter limited its indications to 100 amperes; beyond that point there was a stop pin.

The diagram presented in the engraving shows graphically, as nearly as was possible to reproduce it, the varying quantity of power input required during a cycle of cutting and reversal movement of the work. At the moment of the reverse from the cutting to the return stroke, the pointer on ammeter went hard against the stop pin, rebounding slightly each time, thus preventing correct reading at this period. The extreme amount at that period is here assumed as 120 amperes, which is undoubtedly somewhat low.

Reference to the diagram will show that during the cut (between points A and B) from 10 to 20 amperes were used, the average being about 15. At the time of reverse from cut to return, 120 (assumed) amperes were used; during the return motion this dropped to 40 amperes. At the time of the reverse from return to cut, 80 amperes were required, which quickly dropped to 10 amperes at the beginning of the cut.

From this data we have the following:

Power required to reverse from cut to return = 40.2 H.P.
Average power required during return stroke = 22 H. P.
Power required at reverse from return to cut = 26.8 H. P.
Average power required during cutting stroke = 5 H.P.

From this it may be seen that at the instant of reversal of the platen from the cutting to the return stroke, a surge of power equal to eight times that required for the cut was demanded.

The machine was working at a rate of six strokes per minute, and the amount of metal removed per minute was 2 cu. ins. Ten amperes being the lowest amount required during the cutting stroke it is assumed that the power required to move the platen, countershaft, pulleys, belts, etc. = 3.35 h. p. and the power required to remove the metal = 1.65 h. p., or .825 h. p per cu. in.

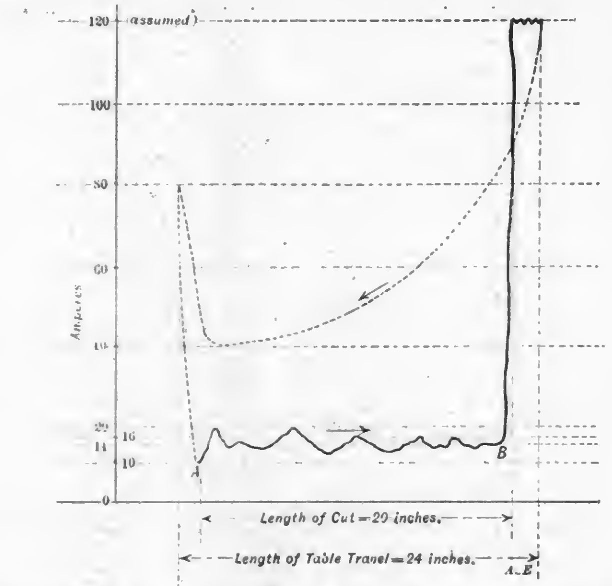


DIAGRAM SHOWING CURRENT REQUIRED DURING A COMPLETE CYCLE OF THE PLANER'S MOVEMENTS.

While this figure agrees very closely with one which is used by a certain electrical engineer for estimating purposes, it is of value only for similar conditions, as to metal, shape of tool, depth of cut, and amount of feed. The power necessary to move the platen alone could, of course, have been more closely obtained had time allowed.

The conditions noted are about the worst under which the machine could be operated, from an economical standpoint. These conditions are that of the heavy platen worked at short stroke, which means poor lubrication and frequent reversals, and only one tool at a comparatively light cut. The average power required for operating this machine under the conditions noted = 11.6 h. p. If the power cost per horse-power-hour be taken as unity, and 120 cu. ins. of metal were removed per hour, then 10.3 cu. ins. were removed for each unit of horse power cost.

Could this same cut have been taken at the full length of platen travel, the average horse power would probably not have been over 8.1 h. p. This would correspond to the removal of nearly 15 cu. ins. per unit of power cost. Again, could the four tools have been at work under the same conditions of material, cut, etc., the average power used would have been about 11.5 h. p., but the metal removed would have been four times as great, or 480 cu. ins. per hour—at the rate of 41.7 cu. ins. per unit of power cost. While these figures are not exact, they are sufficiently close for approximate comparison.

A train of 25 English cars was required to carry the 125 in. Bement-Miles crankshaft lathe recently shipped over the Manchester Ship Canal Company's tracks, on its way to the Manchester works of the Westinghouse Electrical & Manufacturing Company. This interesting fact was noted recently in the *American Machinist*, in an illustrated description. The lathe has a bed 64 ft. long and will swing pieces 45 ft. long.

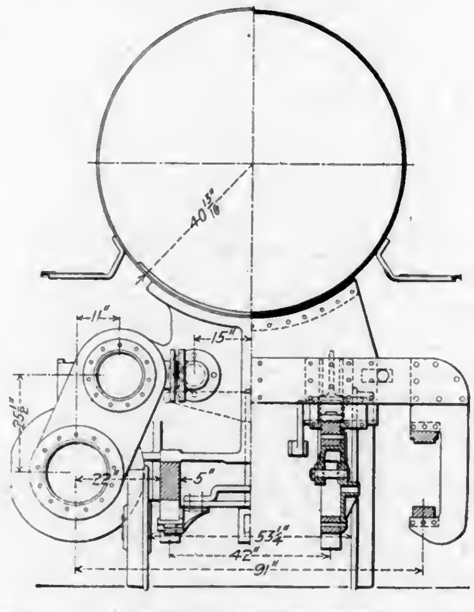
TANDEM COMPOUND FREIGHT LOCOMOTIVE.

2—8—0 TYPE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

As a result of favorable experience with the experimental locomotive of this type, illustrated in these pages last month, the Schenectady Works of the American Locomotive Company have delivered a number of more powerful locomotives of the same type, which are the most powerful ever used on this road. This class is known as "G-4" and the tractive effort is 47,500 lbs., which gives them the rating of 47.570 on a basis of 100,000 lbs. as 100 per cent. The experimental design was rated at 39 per cent. The new class has 4,116 sq. ft. of heating surface, a figure which is exceeded by only four locomotives in our record. This surface is obtained with a 77-in. boiler and tubes 14 ft. 9 ins. long.

The cylinders are 16 and 30 by 30 ins. Both cylinders have piston valves, which are exactly alike. By using crossed

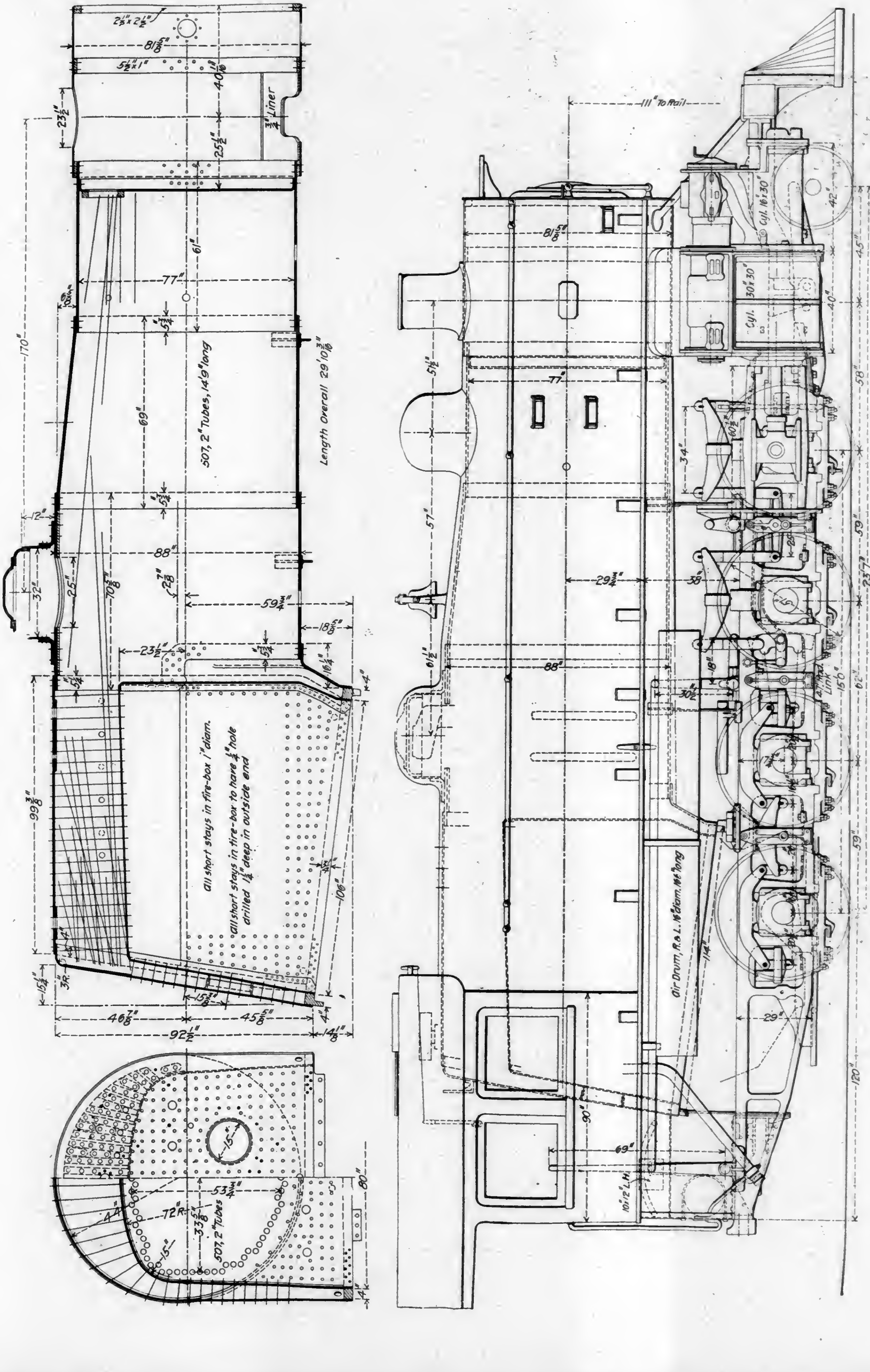


CROSS SECTION.—TANDEM-COMPOUND FREIGHT LOCOMOTIVE. NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

ports for the high pressure cylinders the high pressure valve gives inside admission and the low pressure valve gives outside admission. This construction and the arrangement of the cylinders closely resemble the first Schenectady tandem compound for the Northern Pacific (AMERICAN ENGINEER, September, 1901, page 271). For packing the piston rod between the cylinders a brass floating bushing is used as before, but in this case it has water grooves and is lubricated from the cab. To take out the low pressure packing rings the high pressure piston is removed by a clamp, the back head of the low pressure cylinder is loosened, the vertical portion of the guide yoke is unbolted from the horizontal portion and the guides come away with the head and the yoke without disturbing the alignment of the guides. It is now customary on this road to provide all new locomotives with cylinder bushings. This is done for the high pressure cylinders in this case, but not for the low pressure, because of their large diameter. The arrangement of the valves and cylinders on one side of the engine is as shown on page 276 of this journal for September, 1901.

The frames are very heavy, being 5 ins. wide throughout their length. They are of cast steel, having forked back ends for the front portions. At the cylinders these have a section of 5 by 10 ins. In large engines thimble pedestal binders are giving place to the older form of straps. In this case cast steel is used and the straps have toes 2 ins. deep.

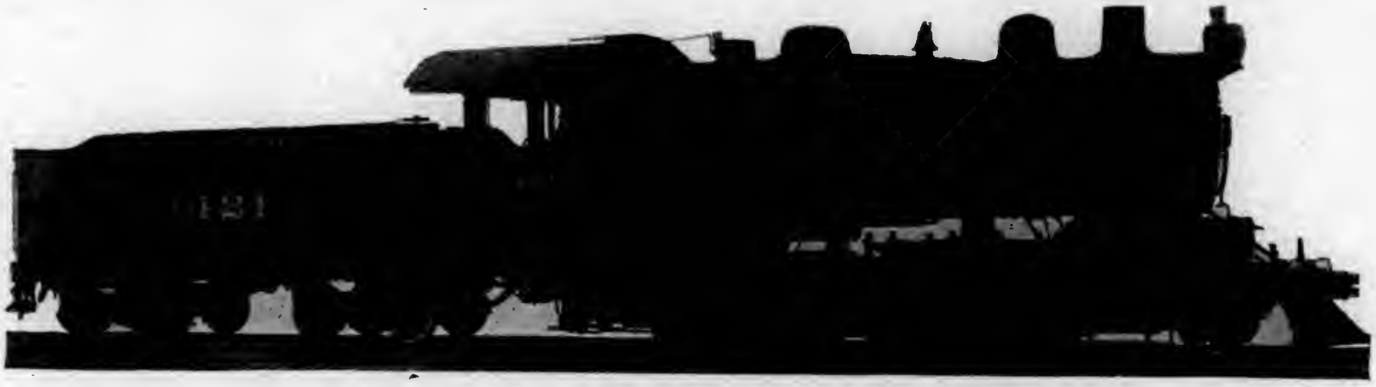
This boiler is the largest ever used on this road. It has a



TANDEM COMPOUND FREIGHT LOCOMOTIVE.—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

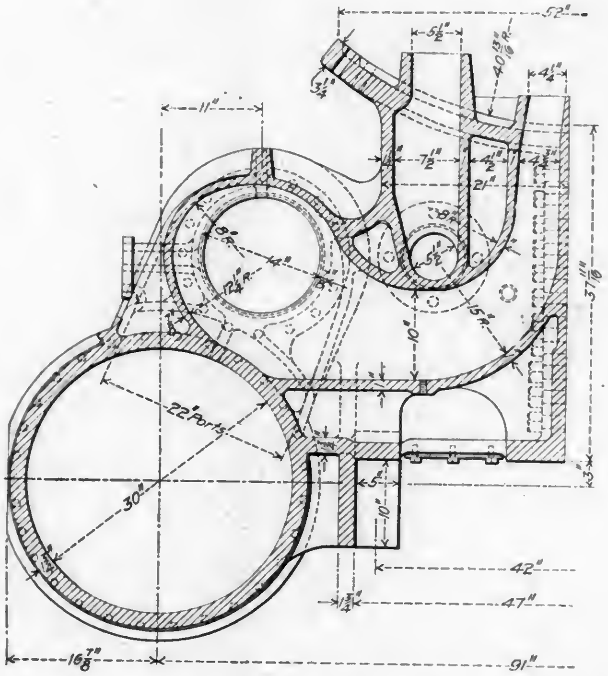
2—8—0 TYPE.

AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders*.

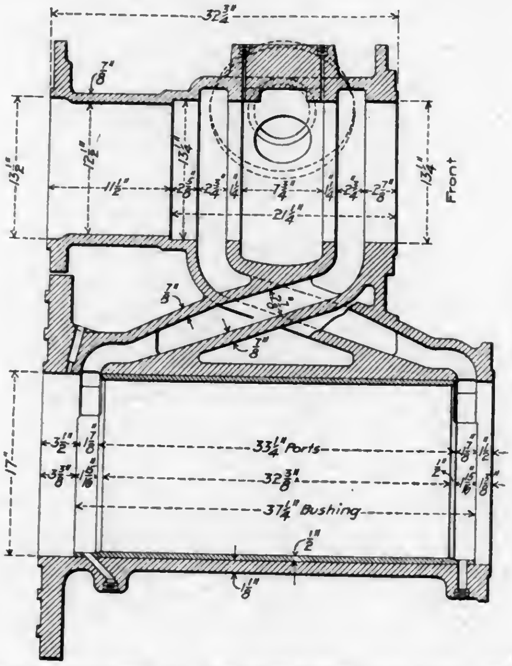


TANDEM-COMPOUND FREIGHT LOCOMOTIVE.—2-8-0 TYPE.
NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

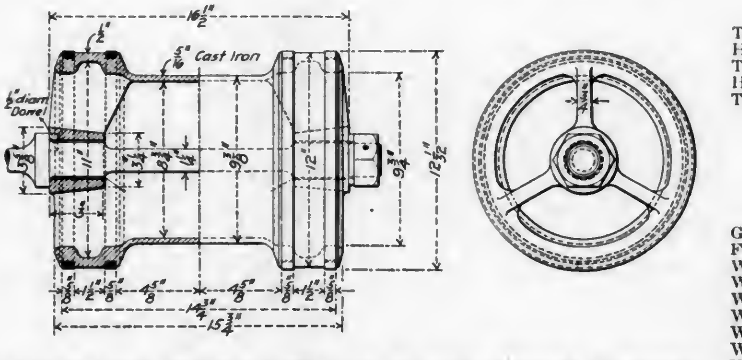
AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*



CROSS SECTION OF LOW-PRESSURE CYLINDER AND VALVE.



LONGITUDINAL SECTION OF HIGH-PRESSURE CYLINDER AND VALVE, SHOWING CROSSED PORTS.



PISTON VALVE, USED FOR BOTH HIGH AND LOW PRESSURE CYLINDERS.

curved crown sheet and a steam space of 23 ins. over the crown sheet, which is liberal for so large a boiler. The front end is short and has no cinder pocket. In order to obtain a good attachment for the cylinders the smokebox has two 5½ by 1 in. rings, one at the tube sheet and the other at the extension joint. Two 16 by 166 in. main reservoirs furnish a large air storage capacity.

The following ratios and list of dimensions furnish means for comparisons with other **engines:**

RATIOS.

Heating surface to volume of high-pressure cylinders	= 591.4
Tractive weight to heating surface	= 48.6
Tractive weight to tractive effort	= 4.2
Tractive effort to heating surface	= 11.5
Heating surface to grate area	= 70.9
Tractive effort × diameter of drivers to heating surface	= 588.6
Heating surface to tractive effort	= 8.6%
Total weight to heating surface	= 54.7

TANDEM COMPOUND FREIGHT LOCOMOTIVE.

2—8—0 Type.

New York Central & Hudson River Railroad.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	225,000 lbs.
Weight on drivers	200,000 lbs.
Weight engine and tender in working order	360,500 lbs.
Wheel base, driving	15 ft.
Wheel base, rigid	15 ft.
Wheel base, total	23 ft. 5 ins.
Wheel base, total, engine and tender	59 ft. 3 ins.

Cylinders.

Diameter of cylinders	16 and 30 ins.
Stroke of piston	30 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	h. p., 3 ins.; l. p., 4 ins.
Kind of piston-rod packing	Gibbs vibrating cup

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	⅞ in.
Inside clearance of slide valves	H. p., 0 in.; l. p., ¼ in.
Lead of valves in full gear:	Line and line F. & B. ¼ in. lead at half stroke

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	51 ins.
Material of driving wheels, centers	Cast steel
Thickness of tire	3½ ins.
Diameter and length of driving journals:	Main, 10 ins.; others, 9½ x 12 ins.

Diameter and length of main crankpin journals	7 ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals:	Front, 5 x 4 ins.; back, 5 x 4¼ ins; inter., 5½ ins. diam. x 5 ins.
Engine truck, kind	Two-wheel, swing bolster
Engine truck, journals	6¼ ins. diameter x 10 ins.
Diameter of engine truck wheels	30 ins.
Kind of engine truck wheels	Krupp steel tire

Boiler.

Style	Extended wagon top
Outside diameter of first ring	77 ins.
Working pressure	210 lbs.
Thickness of plates in barrel and outside of firebox:	13-16, 15-16, 9-16, 1, ¾, ⅝ and ⅞ in.
Firebox, length	105 ins.
Firebox, width	79¼ ins.
Firebox, depth	Front, 82 ins.; back, 65 ins.
Firebox plates, thickness:	Sides, 5-16 in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, 9-16 in.
Firebox, water space	4 ins. front, 4 ins. sides, 4 ins. back
Firebox, crown staying	Radial stays screw through crown and shell except 6 center rows to have button heads under crown and 3 front transverse rows expansion stays
Firebox, staybolts	Taylor iron, 1 in. diameter, 4-in. centers
Tubes, number	507
Tubes, diameter	2 ins.
Tubes, length over tube sheets	14 ft. 9 ins.
Firebrick, supported on	Tubes
Heating surface, tubes	3 889.3 sq. ft.
Heating surface, water tubes	26 sq. ft.
Heating surface, firebox	201.2 sq. ft.
Heating surface, total	4,116.5 sq. ft.
Grate surface	58 sq. ft.
Ashpan, style	Hopper, sectional
Exhaust pipes	Single, low
Exhaust nozzles	5, 5¼, and 5⅜ ins. diameter
Smokestack, inside diameter	20 ins.
Smokestack, top above rail	14 ft. 10 ins.
Boiler supplied by	Monitor injector No. 11

Tender.

Style	Water bottom
Weight empty	(Est.) 51,500 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	20 ft. 3 ins.
Tender frame	10-in. steel channels
Tender trucks	Two-wheel, center bearing, Fox pressed steel bolsters
Water capacity	7,000 U. S. gals.
Coal capacity	12 tons

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

The draughting-room is becoming an index of the character of a motive power organization. By a visit to the draughting-room one may form a correct opinion not only as to the kind of men in charge of the department, but of the probability of their advancement. The contrasts in draughting-rooms are becoming more striking, and, in fact, impressive.

A large road, which in the past has been noted as progressive, is now found to have a draughting-room filled with men some of whom have been there for many years, who have worked at the same tables, doing the same kind of work, accompanied by a sprinkling of youngsters from the shop. The room is in a dirty place, next to a roundhouse, with an ash-pit on one side and coal chutes on the other. The room is crowded, poorly lighted, unventilated, littered with old drawings and generally slovenly. The presence of the old men indicates that the draughting-room is a pocket in which the faithful draughtsman is allowed to remain until he becomes unambitious. The presence of the boys from the shop is a good feature, but in this instance it seems to give the impression of a desire to run the room cheaply, there are so many of them.

This draughting-room was not always in this condition, and that it has been allowed to drift indicates a lack of appreciation on the part of the department officers of one of the most useful and profitable tools given to their hands to use. The draughting-room cannot possibly be what it should be under any such conditions. Instead of being an important part of the brains of the department, it seems to be considered a necessary evil, and those who are condemned to its imprisonment are to be pitied.

These comments are suggested by conversation between the visitor and the men in the leisure of the noon hour. The subjects of the railway clubs and technical press were mentioned. The draughtsmen showed little interest in either, which led the visitor to remark that if they would read a good technical paper and follow the work of the railway clubs they might perhaps obtain advancement. It would be perfectly safe to make a rule to discharge draughtsmen or foremen who do not familiarize themselves, through a technical paper and the railroad clubs, with general progress in their line of work.

A very pleasing contrast was found on another and much smaller road, where the draughting-room was large, bright, clean and orderly, and full of earnest, interested and bright-looking young men. It was, in fact, a busy workshop, telling of the pride of the officers of the road in an efficient working department. It is evidently considered as a channel through which the men may pass into other branches, and is not allowed to become an ambition-killing pocket. It is easy to predict a bright and growing future, not only for the young men in this draughting-room, but for the superior officers of the department, who are broad-minded enough to make the draughting-room contribute to their success.

It is hoped that those to whom these paragraphs may apply will read them. It is also hoped that discouraged draughtsmen will read them. The draughting-room is one of the best schools of experience to be had on a railroad, but it is not a place in which a good man should stay until he is old. It is not difficult to get out of the draughting-room if a man shows by his work as a draughtsman his ability to carry executive responsibilities. Good foremen are always in demand, and this should be noted by the draughtsman who has executive ability.

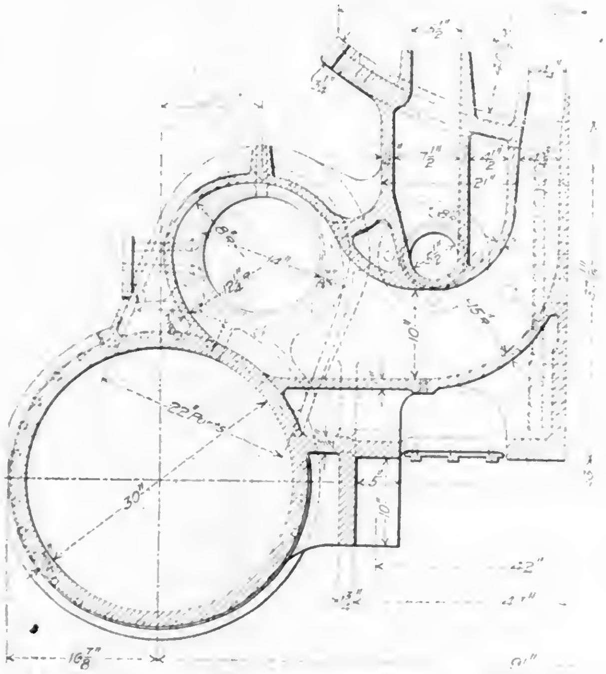
Electric distribution of power is a feature of every plan for extending railroad shop plants and of every new plant. The progress of the last five years in this direction has been phenomenal. In all cases the plans for power houses provide for extension when the demand for power shall increase beyond a reasonable overload for the equipment which is installed. But there is danger of providing too little space for this purpose. The convenience of electric driving is such as to lead to unexpected extensions, and while going to the expense of erecting a power house, a larger provision for the future should be made. In the case of the shop improvements on the Chicago & Northwestern Railway, completed about two years ago, the power house was made large enough for an increase of 100 per cent., and now the only available space remaining is that which will soon be required for another air compressor. A new Allis-Chalmers cross-compound vertical engine is now nearly ready for service. It is direct-coupled to a 500-kw. General Electric generator furnishing 2,000 amperes at 250 volts. The engine has 22 and 36 x 42-in. cylinders and operates non-condensing. An engine of this character gives a power house a business-like appearance; and that a capacity of 500 kw. is needed is an indication of the possibilities of the growth of electric power distribution.

When constructing a power house of large capacity, the steam and electrical engineering problems become interesting, and an opportunity is offered for the application of good business and engineering judgment. This constitutes a new field on steam railways and a new opportunity is offered for young men who are thoroughly informed on electric and steam engineering questions. Railroad shops are nearly always located near large cities in order to secure a good labor market. Railroads always have a large amount of lighting at such points, and they are beginning to appreciate the opportunities for extending their central power station functions to include station and yard, as well as shop lighting. In several places plants of this kind are being worked out.

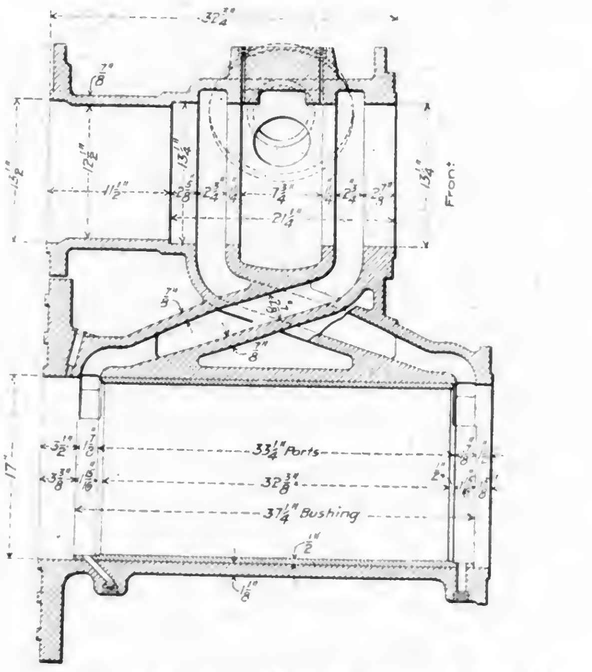
In several of the older shops visited bolt and even forging machines were found in small buildings at some considerable distance from the machine or blacksmith shops, and in one case this machinery was placed in a corner of the erecting shop. This location was selected because the space was available, and without thought of the fact that convenience to the stock of supplies and easy supervision are important for such work. While such locations may sometimes be justified, this sort of thing is typical of the old school of railroad shop management, in which commercial questions were not given sufficient attention. Such mistakes are not made in successful commercial establishments, and they are fortunately becoming less frequent in railroad shops.

TANDEM-COMPOUND FREIGHT LOCOMOTIVE.—2-8-0 TYPE.
NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

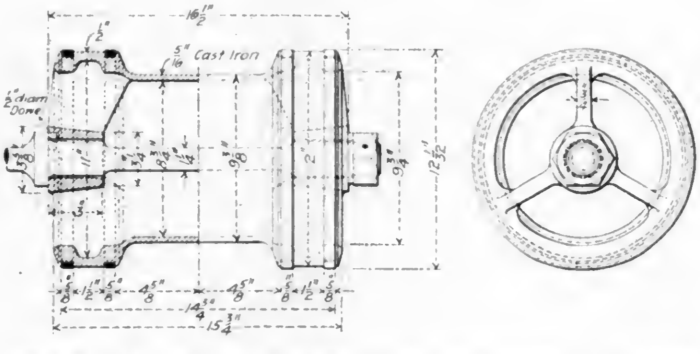
AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*



CROSS SECTION OF LOW-PRESSURE CYLINDER AND VALVE.



LONGITUDINAL SECTION OF HIGH-PRESSURE CYLINDER AND VALVE, SHOWING CROSSED PORTS.



PISTON VALVE, USED FOR BOTH HIGH AND LOW PRESSURE CYLINDERS.

curved crown sheet and a steam space of 23 ins. over the crown sheet, which is liberal for so large a boiler. The front end is short and has no cinder pocket. In order to obtain a good attachment for the cylinders the smokebox has two $5\frac{1}{2}$ by 1 in. rings, one at the tube sheet and the other at the extension joint. Two 16 by 166 in. main reservoirs furnish a large air storage capacity.

The following ratios and list of dimensions furnish means for comparisons with other engines:

RATIOS.

Heating surface to volume of high-pressure cylinders	= 591.4
Tractive weight to heating surface	= 48.6
Tractive weight to tractive effort	= 4.2
Tractive effort to heating surface	= 11.5
Heating surface to grate area	= 70.9
Tractive effort × diameter of drivers to heating surface	= 588.6
Heating surface to tractive effort	= 8.6%
Total weight to heating surface	= 51 7

TANDEM COMPOUND FREIGHT LOCOMOTIVE.

2—8—0 Type.

New York Central & Hudson River Railroad.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	225,000 lbs.
Weight on drivers	200,000 lbs.
Weight engine and tender in working order	360,500 lbs.
Wheel base, driving	15 ft.
Wheel base, rigid	15 ft.
Wheel base, total	23 ft. 5 ins.
Wheel base, total, engine and tender	59 ft. 3 ins.

Cylinders.

Diameter of cylinders	16 and 30 ins.
Stroke of piston	30 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	h. p., 3 ins.; l. p., 4 ins.
Kind of piston-rod packing	Gibbs vibrating cup

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	⅞ in.
Inside clearance of slide valves	H. p., 0 in.; l. p., ¼ in.
Lead of valves in full gear:	Line and line F. & B. ¼ in. lead at half stroke

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	51 ins.
Material of driving wheels, centers	Cast steel
Thickness of tire	3½ ins.
Diameter and length of driving journals:	Main, 10 ins.; others, 9½ x 12 ins.

Diameter and length of main crankpin journals..7 ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals:
Front, 5 x 4 ins.; back, 5 x 4¼ ins; inter., 5½ ins. diam. x 5 ins.
Engine truck, kind ....Two-wheel, swing bolster
Engine truck, journals ....6¼ ins. diameter x 10 ins.
Diameter of engine truck wheels........................30 ins.
Kind of engine truck wheels........................Krupp steel tire

Boiler.

Style ....Extended wagon top
Outside diameter of first ring........................77 ins.
Working pressure ....210 lbs.
Thickness of plates in barrel and outside of firebox:
13-16, 15-16, 9-16, 1, ¾, ⅝ and ⅞ in.
Firebox, length ....105 ins.
Firebox, width ....79¼ ins.
Firebox, depth ....Front, 82 ins.; back, 65 ins.
Firebox plates, thickness:
Sides, 5-16 in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, 9-16 in.
Firebox, water space..............4 ins. front, 4 ins. sides, 4 ins. back
Firebox, crown staying..Radial stays screw through crown and shell except 6 center rows to have button heads under crown and 3 front transverse rows expansion stays
Firebox, staybolts............Taylor iron, 1 in. diameter, 4-in. centers
Tubes, number 507
Tubes, diameter ....2 ins.
Tubes, length over tube sheets........................14 ft. 9 ins.
Firebrick, supported on........................Tubes
Heating surface, tubes ....3 889.3 sq. ft.
Heating surface, water tubes ....26 sq ft.
Heating surface, firebox ....201.2 sq. ft.
Heating surface, total ....4,116.5 sq. ft.
Grate surface ....58 sq. ft.
Ashpan, style ....Hopper, sectional
Exhaust pipes ....Single, low
Exhaust nozzles ....5, 5¼, and 5⅜ ins. diameter
Smokestack, inside diameter ....20 ins.
Smokestack, top above rail ....14 ft. 10 ins.
Boiler supplied by........................Monitor injector No. 11

Tender.

Style ....Water bottom
Weight empty ....(Est.) 51,500 lbs.
Wheels, number 8
Wheels diameter ....33 ins.
Journals, diameter and length............5½ ins. diameter x 10 ins.
Wheel base ....20 ft. 3 ins.
Tender frame ....10-in. steel channels
Tender trucks....Two-wheel, center bearing, Fox pressed steel bolsters
Water capacity ....7,000 U. S. gals.
Coal capacity ....12 tons

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

The draughting-room is becoming an index of the character of a motive power organization. By a visit to the draughting-room one may form a correct opinion not only as to the kind of men in charge of the department, but of the probability of their advancement. The contrasts in draughting-rooms are becoming more striking, and, in fact, impressive.

A large road, which in the past has been noted as progressive, is now found to have a draughting-room filled with men some of whom have been there for many years, who have worked at the same tables, doing the same kind of work, accompanied by a sprinkling of youngsters from the shop. The room is in a dirty place, next to a roundhouse, with an ash-pit on one side and coal chutes on the other. The room is crowded, poorly lighted, unventilated, littered with old drawings and generally slovenly. The presence of the old men indicates that the draughting-room is a pocket in which the faithful draughtsman is allowed to remain until he becomes unambitious. The presence of the boys from the shop is a good feature, but in this instance it seems to give the impression of a desire to run the room cheaply, there are so many of them.

This draughting-room was not always in this condition, and that it has been allowed to drift indicates a lack of appreciation on the part of the department officers of one of the most useful and profitable tools given to their hands to use. The draughting-room cannot possibly be what it should be under any such conditions. Instead of being an important part of the brains of the department, it seems to be considered a necessary evil, and those who are condemned to its imprisonment are to be pitied.

These comments are suggested by conversation between the visitor and the men in the leisure of the noon hour. The subjects of the railway clubs and technical press were mentioned. The draughtsmen showed little interest in either, which led the visitor to remark that if they would read a good technical paper and follow the work of the railway clubs they might perhaps obtain advancement. It would be perfectly safe to make a rule to discharge draughtsmen or foremen who do not familiarize themselves, through a technical paper and the railroad clubs, with general progress in their line of work.

A very pleasing contrast was found on another and much smaller road, where the draughting-room was large, bright, clean and orderly, and full of earnest, interested and bright-looking young men. It was, in fact, a busy workshop, telling of the pride of the officers of the road in an efficient working department. It is evidently considered as a channel through which the men may pass into other branches, and is not allowed to become an ambition-killing pocket. It is easy to predict a bright and growing future, not only for the young men in this draughting-room, but for the superior officers of the department, who are broad-minded enough to make the draughting-room contribute to their success.

It is hoped that those to whom these paragraphs may apply will read them. It is also hoped that discouraged draughtsmen will read them. The draughting-room is one of the best schools of experience to be had on a railroad, but it is not a place in which a good man should stay until he is old. It is not difficult to get out of the draughting-room if a man shows by his work as a draughtsman his ability to carry executive responsibilities. Good foremen are always in demand, and this should be noted by the draughtsman who has executive ability.

Electric distribution of power is a feature of every plan for extending railroad shop plants and of every new plant. The progress of the last five years in this direction has been phenomenal. In all cases the plans for power houses provide for extension when the demand for power shall increase beyond a reasonable overload for the equipment which is installed. But there is danger of providing too little space for this purpose. The convenience of electric driving is such as to lead to unexpected extensions, and while going to the expense of erecting a power house, a larger provision for the future should be made. In the case of the shop improvements on the Chicago & Northwestern Railway, completed about two years ago, the power house was made large enough for an increase of 100 per cent., and now the only available space remaining is that which will soon be required for another air compressor. A new Allis-Chalmers cross-compound vertical engine is now nearly ready for service. It is direct-coupled to a 500-kw. General Electric generator furnishing 2,000 amperes at 250 volts. The engine has 22 and 36 x 42-in. cylinders and operates non-condensing. An engine of this character gives a power house a business-like appearance; and that a capacity of 500 kw. is needed is an indication of the possibilities of the growth of electric power distribution.

When constructing a power house of large capacity, the steam and electrical engineering problems become interesting, and an opportunity is offered for the application of good business and engineering judgment. This constitutes a new field on steam railways and a new opportunity is offered for young men who are thoroughly informed on electric and steam engineering questions. Railroad shops are nearly always located near large cities in order to secure a good labor market. Railroads always have a large amount of lighting at such points, and they are beginning to appreciate the opportunities for extending their central power station functions to include station and yard, as well as shop lighting. In several places plants of this kind are being worked out.

In several of the older shops visited bolt and even forging machines were found in small buildings at some considerable distance from the machine or blacksmith shops, and in one case this machinery was placed in a corner of the erecting shop. This location was selected because the space was available, and without thought of the fact that convenience to the stock of supplies and easy supervision are important for such work. While such locations may sometimes be justified, this sort of thing is typical of the old school of railroad shop management, in which commercial questions were not given sufficient attention. Such mistakes are not made in successful commercial establishments, and they are fortunately becoming less frequent in railroad shops.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

V.

BY C. W. OBERT.

The most extensive use of the positive-drive variable-speed mechanism has been made by the Bickford Drill and Tool Company, Cincinnati, Ohio, who have utilized it not only for the feeds but also for the main drives of their Bickford radial drills. The manifest advantages of the gear-drive mechanism over the cone-pulley-and-belt method of driving offer strong inducements to its use on main drives and it has proved very successful in this application.

The main drive of the Bickford drill is through two independent change gear mechanisms, one at the base of the column, X, and the other, Y, at the rear of the arm, as shown in Figs. 22 and 24, and also in Fig. 21. The main speed box, X, receives power on pulley, P, and delivers to a vertical shaft within the column. The vertical shaft drives back gear box Y through gears at the top of the column and a splined shaft extending down along the rear to permit vertical adjustments of the arm; from the back gear mechanism the drill spindle is driven direct.

Figs. 22 and 23 present an external and a sectional view of the main speed box, X. Power is received on pulley P of the device, which is keyed to the driving shaft S, Fig. 23. Upon this shaft S is keyed the four gears, A, B, C and D, of varying sizes, and each one of these gears meshes with a corresponding gear running loose on the driven shaft, T, as shown at E, F, G and K. The four different speeds available through these combinations are obtained by throwing one of the clutches, M or N, in the proper direction, which is accomplished by the handle L.

The proper direction in which to throw handle, L, is indicated on the upper side of the gear case (see Fig. 22), at the opening through which the handle projects. This opening is shaped like a letter "H" laid sideways, and each of its four corners or slots are numbered in succession from 1 to 4, as shown in Fig. 22. The lever L is capable of being swung in two directions, so that it may be set over into line with either pair of slots, 1 and 2 or 3 and 4, and then may be thrown into either slot of that pair.

The lever L is arranged to positively operate a different clutch for either pair of slots in the "H." Thus, when in either slot 1 or 2, clutch N is actuated and clutch M is locked in a central position; when handle L is in slots 3 or 4, clutch M is in use and N is locked out of clutch.

Four speeds are also available from the back gear box, Y. This device consists of a three-shaft change-gear arrangement in which two double-throw clutches are operated by the handles, Q and R, Figs. 21 and 24. This device is similar in principle to the four-speed change gear mechanism described on page 143 (Fig. 18) of the preceding article of this series, which mechanism was, we are informed, suggested by the speed box used by the Bickford Company, who were the first to make use of this type of mechanism. Friction clutches are used in this device to permit clutching and disengagement without noise or shock while the machine is running. It is arranged so that each speed transmits to the spindle more than double the pulling power of the next faster speed.

These two devices thus afford a possible variation of sixteen

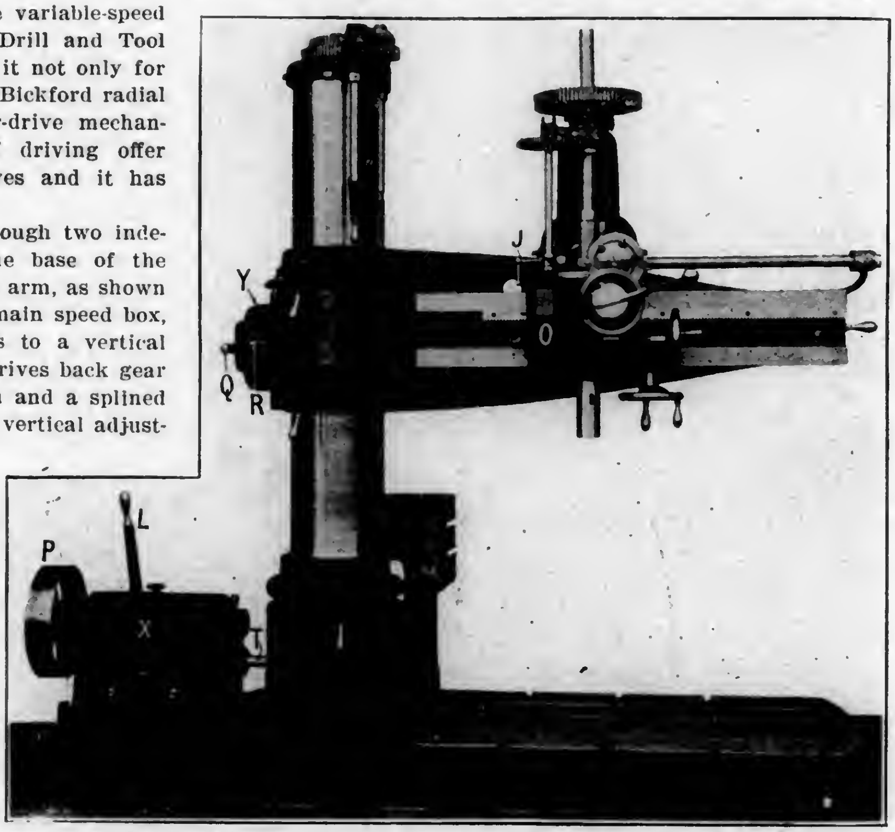


FIG. 21.—THE BICKFORD RADIAL DRILL. EQUIPPED WITH VARIABLE-SPEED GEARED DRIVE AND FEED.
THE BICKFORD DRILL AND TOOL COMPANY.

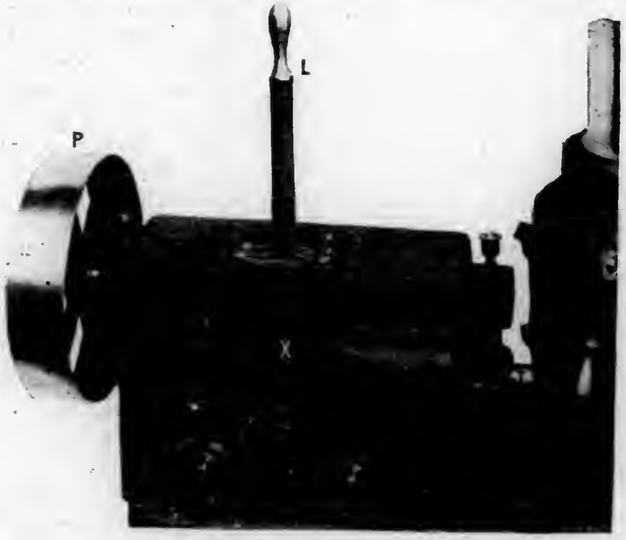


FIG. 22.—VIEW OF THE MAIN DRIVE SPEED BOX, SHOWING THE "H" SLOT ARRANGEMENT FOR CONTROLLING THE FOUR CLUTCHES WITH ONE LEVER.

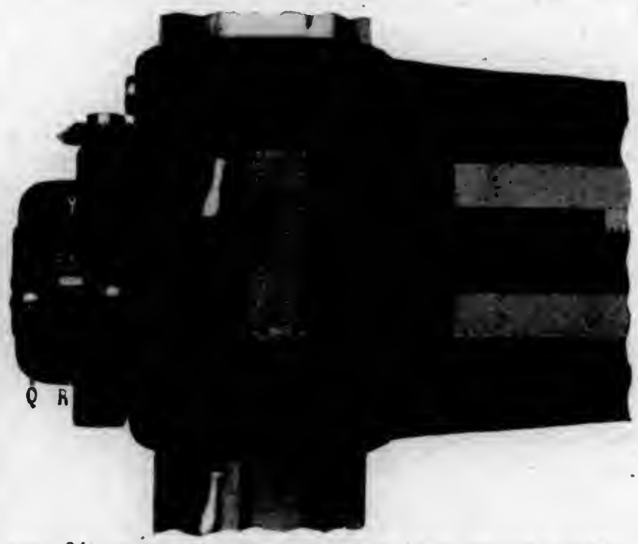


FIG. 24.—VIEW OF THE BACK GEAR BOX ON THE ARM. THIS MECHANISM IS DRIVEN THROUGH A SPLINED SHAFT AT THE REAR OF THE COLUMN.

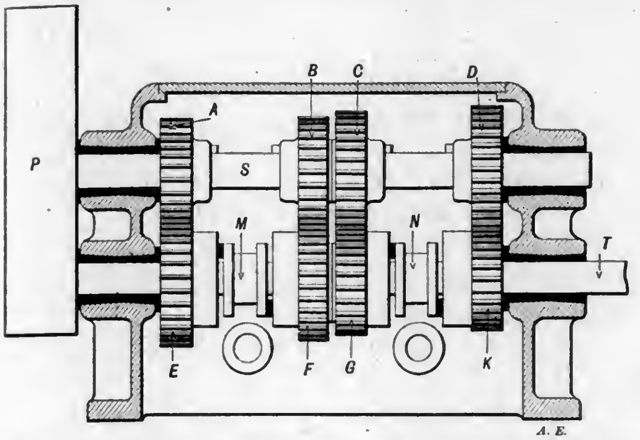


FIG. 23.—LONGITUDINAL SECTION OF THE MAIN DRIVE SPEED BOX.

different speeds, capable of easy and instantaneous changes, and attended with no interruption of power, as is necessary with belt changes. In this way, aside from the many other advantages, the gear-drive mechanism is far superior to the older cone pulley and belt method of driving.

The feed gear box for the drill spindle feeds is mounted on the head at the left of the spindle, as shown at O, Fig. 25, the interior arrangement of which box is shown in Fig. 26. This device consists of a series of loose gears—5, 6, 7 and 8, Fig. 26—which run loosely on shaft W, constantly in mesh with a nest of corresponding driving gears not shown. The method of changing speeds used here is shown at V; the driven shaft, W, has a "pull pin," U, inserted in a hole in its upper end, and a sliding key, V, is hinged to the end of pin U.

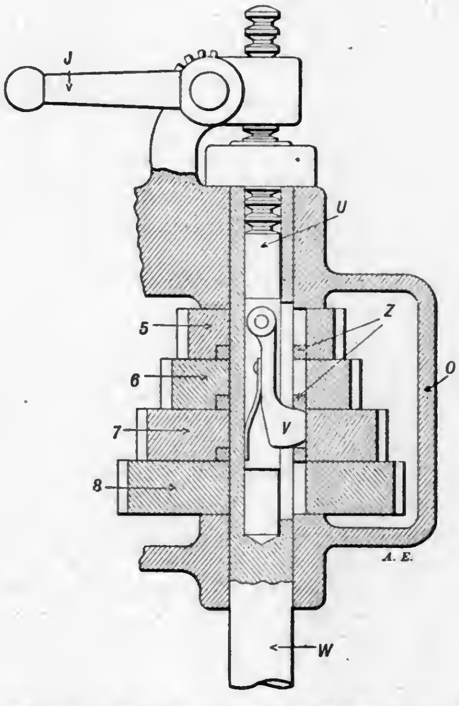


FIG. 26.—VERTICAL SECTION THROUGH THE FEED GEAR BOX SHOWING "PULL PIN" MECHANISM.

This key projects through a slot in the side of shaft W, so as to enter the keyways, of which there are three in the hub of each gear.

Between each of the gears there is a steel ring, Z, which serves to lift key V out and free it from any keyway when shifting to another speed, and then to direct it accurately into a keyway in the next gear as it comes around. The position of the lever, J, a quarter turn of which lever changes the feed to the next either higher or lower gear, indicates which of the gears is operating. This portion of the mechanism furnishes four different speeds, but this is supplemented by a two-speed device, operated by the pull-pin I, shown in Fig. 25, by means of which eight different speeds are made available. A feed-plate is placed upon the case of this feed box which indicates directly the spindle feed that will be obtained with each combination, the range being from .007 to .064 in. per revolution of the spindle.

These applications of the gear method of speed changing make the Bickford drill the most completely equipped for positive driving of any machine tool yet designed. The various devices here shown are praiseworthy for their simplicity and ingenious design, and are unrivaled for ease of manipulation. Steel gears have been found unnecessary with the ample design of parts that is used. The capacity of this drill with the positive drive and feeds is remarkable—a 1½-in. drill has been driven on this machine at a feed of .035 in. per revolution of the spindle through .45 carbon steel.

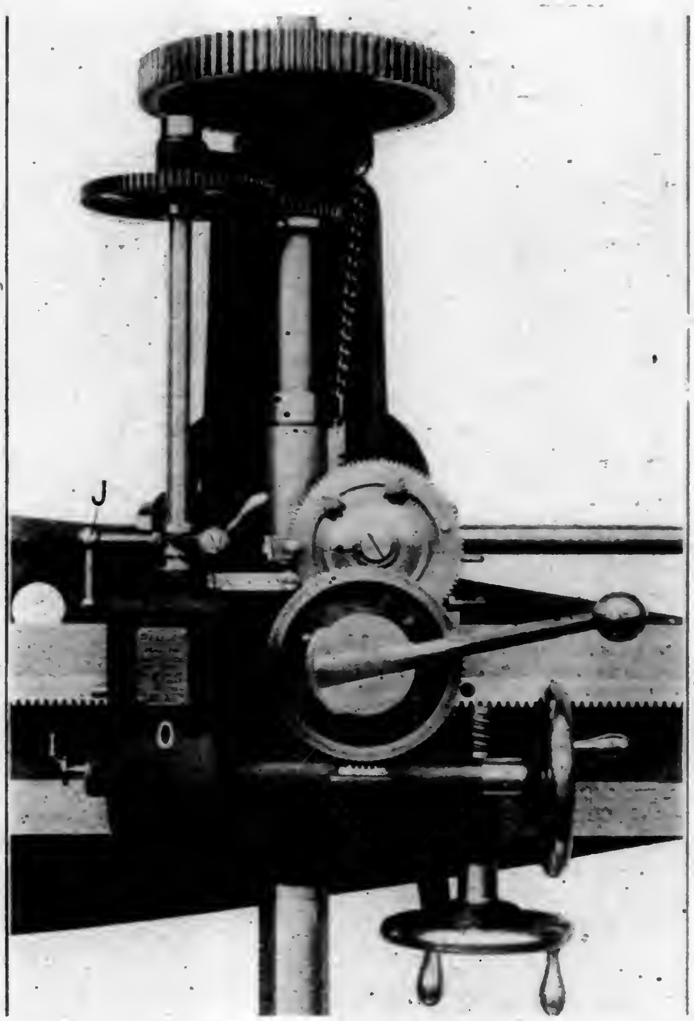


FIG. 25.—VIEW OF THE HEAD SHOWING ARRANGEMENT OF THE FEED GEAR BOX AT THE LEFT OF THE SPINDLE.

Mr. E. H. Harriman is truly one of the busiest men in Wall street, says a writer in the March *Cosmopolitan*, and it is only by the most careful system that he can attend to all of the duties that require his attention. On Thursdays he has about twenty committee meetings to attend. He has so subdivided the time that they succeed one another, at intervals of fifteen to thirty minutes, with the regularity of clockwork. In fact, they are cut short by the clock. In some cases, the performances go off with as much precision as a Punch-and-Judy show—the strings being pulled, as it were, by the power that dominates them. Extensive offices have been fitted up by Mr. Harriman on the fourth floor of one of the largest down town buildings, and the concourse of men passing in and out on Thursdays is an interesting sight.

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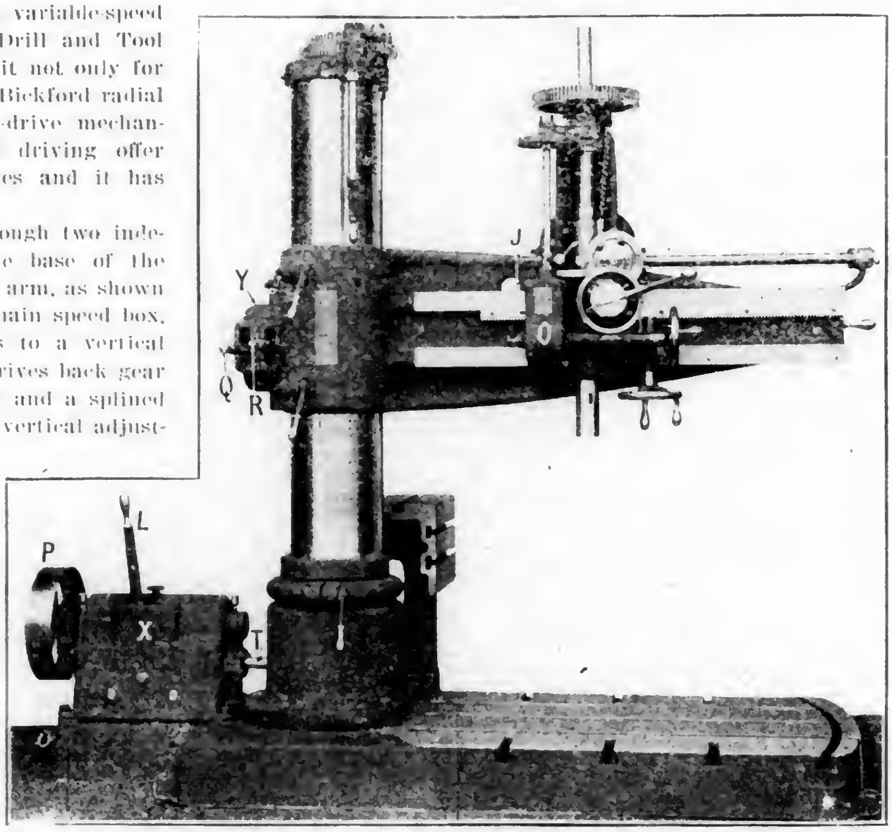

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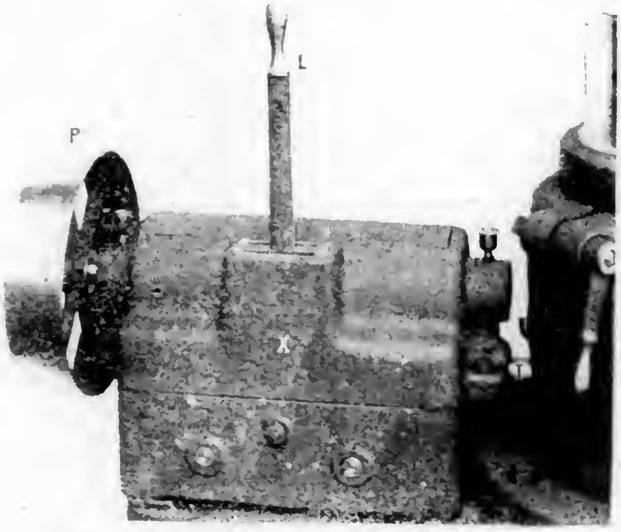

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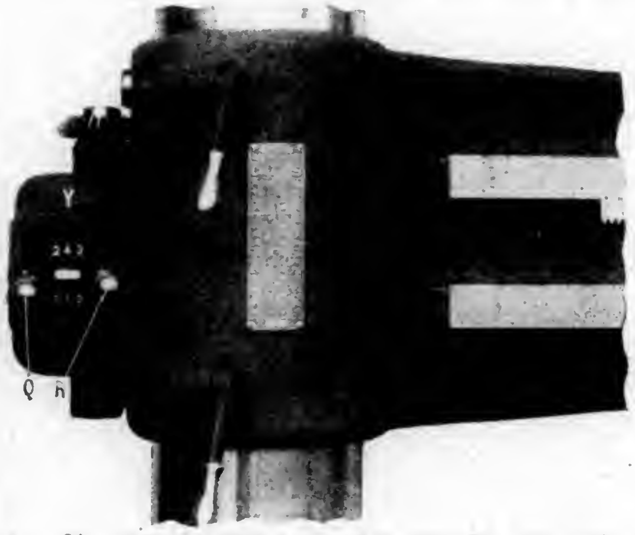

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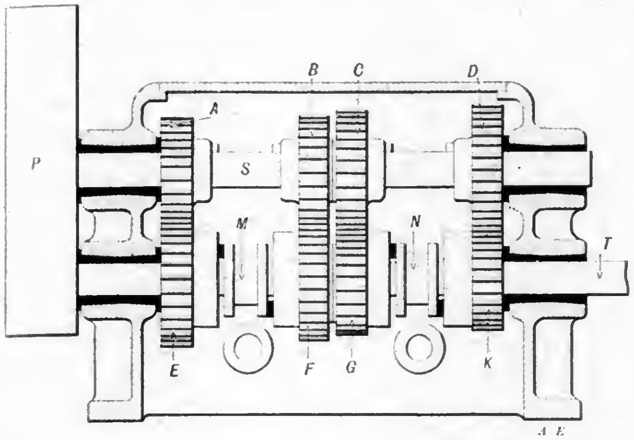

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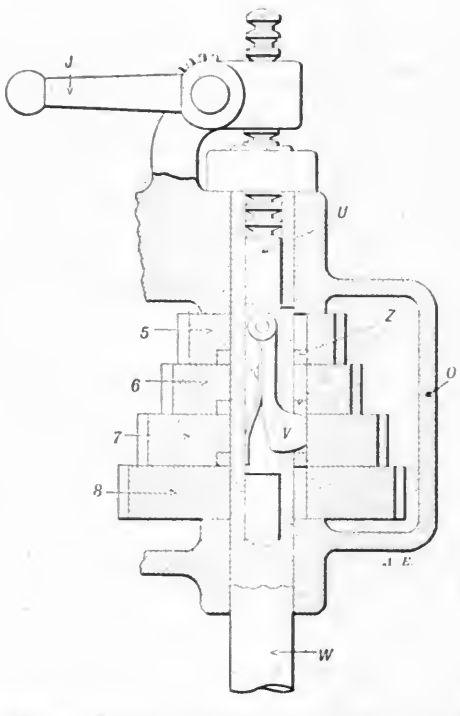

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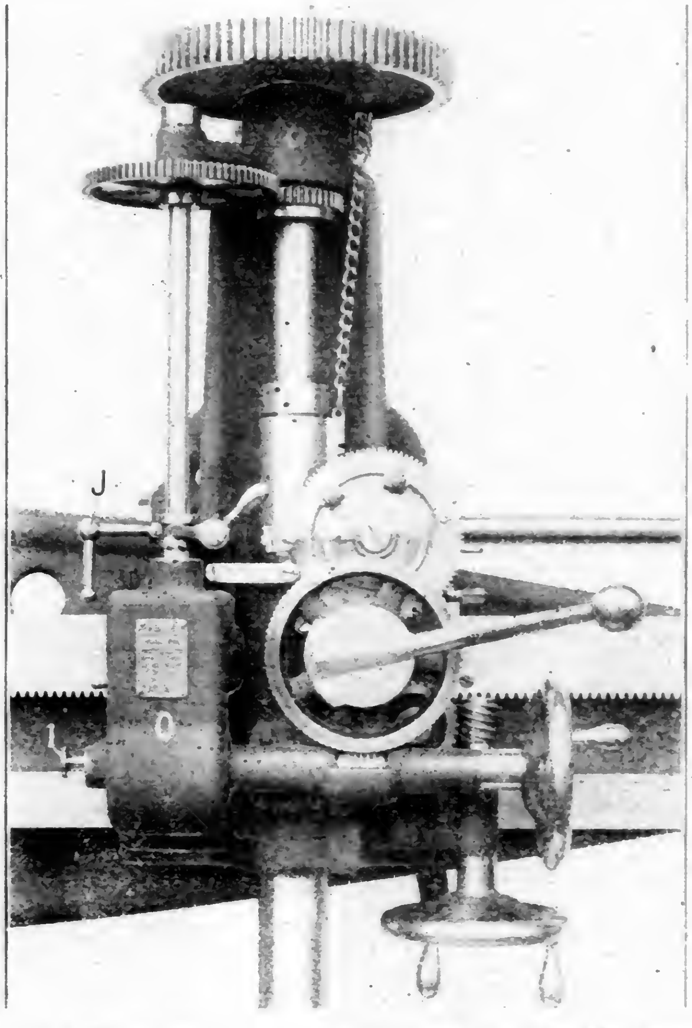

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

WANTED—RESULTS.

Time was, and not so long ago, when all locomotives looked "alike," a car was a car, a machine tool was a machine tool, and all tool steels ran cool. The progress of years has brought comparatively few new fundamental principles of construction, but it has brought an infinite number of improvements in details in all these lines of mechanical development. To-day only the best will answer and the requirements are specialized so that every new addition to equipment is wanted for a definite and specific purpose. This is particularly true of motor driving and machine tools. Nowadays he who is not strictly up-to-date in selecting machinery is not likely to hold his position long, simply because he can not get what is wanted—*results.*

The engineers of the Interborough Rapid Transit Company of New York conducted tests of seven weeks' duration and spent several thousands in preparation for ordering the motor and control equipments for that road. They needed to know what they were doing and it was worth while. Nowadays the mechanical equipment of a new railroad shop costs from a quarter to half a million dollars or more, and such orders must necessarily be carefully placed.

Mechanical railroad men are studying motor driving and machine tools as never before. The best talent available is employed by the machine tool builders to meet and even anticipate the demands and it is the privilege of the technical journal to bring these factors into touch. This journal intends to meet the need and to exert its influence in the interests of advancement and improvement. The campaign now being conducted in these pages meets gratifying encouragement, particularly from the leaders in this improvement, and we shall endeavor to provide a meeting ground for those who know and those who want to know how to apply the best commercial practice to the railroad field.

Here is a three-sided problem. The railroad officer desires to improve his practice, the machine tool builder must supply special machinery for railroad requirements, the electrical people must know how railroad shops are operated. These three do not yet understand each other and only a railroad paper and a policy such as this journal has inaugurated can supply the educational advantages which the present situation requires.

UNIFORMITY IN RAILROAD SIGNALING.

With the increase in the intensity of traffic more and more dependence is placed upon signaling for the safe operation of trains. This fact is made clear by the outcries against "mere visual signals" whenever a collision occurs in a congested district which is supposed to be fully protected by signals. Automatic stops, to take the control of trains out of the hands of the engineers, are strongly advocated after such disasters, and the number of such devices is growing rapidly. The question is, whether the control of the train should be taken out of the hands of the engineer. This must be done if safety demands it, and we may yet come to the point of requiring apparatus of this kind. The public may some time demand automatic stops as they now demand automatic brakes, and if so the flexibility of train operation will be seriously impaired. The automatic stop does not appear to have been developed to a stage which entitles it to the confidence of signal engineers, and the difficulties are great enough to justify skepticism as to whether it ever will command confidence for use on steam roads. Let those interested in this device continue. They cannot fail to benefit the cause of signaling, and they may succeed. But there is much which may be done with present methods which will tend to render these stopping devices unnecessary.

Signaling needs to be made more uniform. Not only should the locations of signals and signaling practice in general be uniform, but the treatment of the application of signaling should indicate the true opinion of signals which is held by the officials of railroads. Locomotive engineers are largely

governed in their use of signals by the opinion of these officers as expressed by the methods used. For example, an engineer must necessarily have a small opinion of automatic block signals when he is governed by them for only a few miles out of an important terminal. Uniformity which takes the form of signaling the entire road is what is needed. Uniformity which is maintained without undue respect to a few dollars in first cost for locating signals where they can be seen without the necessity of carefully hunting for them is also greatly to be desired.

The development of signaling should be in the hands of men wide experience who have sufficient authority to command respect of their opinions and who can make the most of what is now available. It is unfortunate that a department of operation of such importance has not made more progress in the strong current of advancement of the past ten years. The chief want is more signals, more uniformity in practice, and better discipline may then follow. The Railway Signal Association might perform an important service by establishing principles of good signaling as a guide for practice. This, thus far, has not been done.

FLY-WHEELS ON PLANER DRIVES.

It was with considerable surprise that we learned the attitude assumed by one of the most prominent machine tool builders in regard to the desirability of using flywheels upon the driving shafts of motor-driven planers. The fact that the fly-wheel as an auxiliary to the planer drive, as was fully discussed in the article on the motor-driven machine tools at the Collinwood shops of the L. S. & M. S. Railway, in our March, 1903, issue (page 102), was regarded by them as of questionable value, indicates a lack of investigation upon their part of the events attending the cycle of the planer's movements; in fact, it seems that little was known regarding the actual conditions met in driving planers until motor-driving methods came into use.

An interesting statement of the peculiar conditions met in driving planers is presented in an article, on page 174 of this issue, by Mr. J. C. Steen. The conditions actually met in all portions of the cycle of a large planer's movements have been traced by means of the current required by the motor driving it. The results, at least, indicate the fact that, in the absence of a flywheel upon the driving shaft, heavy surges of power are demanded at reversals of the platen, which in the case of motor driving, more particularly, should be avoided.

The tendencies of modern practice seem to indicate that the requirements of railroad repair shops can be most satisfactorily met by a judicious combination of the individual motor-drive and the group driving methods of operating the machine tools. The two principal problems to be met are a simple means of reducing the normal speed of the motor to drive the machine, and a successful method of readily changing the cutting speeds of the machines to suit the varying character of the work. Arrangements for reducing the speed from motor to machine by means of long belts with countershafts on platforms supported from the floor only, have proven unsatisfactory in every way; the noiseless chain belt is now being very extensively and successfully used for this purpose.

That the overlap is not necessary when distant signals are employed in automatic block signalling, was the opinion of twenty-two out of twenty-seven members of the Railway Signaling Club in an informal vote on this question taken at the recent annual meeting. This is an expression of superlative confidence in the discipline of our locomotive engineers. The writer believes that the overlap has not passed its usefulness. As long as appropriations for signals are so limited as to affect their proper application, as long as locomotive engineers must periodically explore the landscape for these signals because of lack of uniformity of location, and as long as these men are expected to haul 600-ton passenger trains at 60 miles per hour with 100-ton locomotives, and are called before their superiors for not making time, the overlap will be needed.

COMMUNICATIONS.

THE SPECIAL APPRENTICE.

To the Editors:

Your views of the special apprentice question are, to say the least, interesting, and, what is more important, they are very nearly right. The writer has probably less cause for complaint than the great majority of this class, as he has had splendid opportunities for getting experience in both car and locomotive work. A man arrives at a stage sooner or later, however, when he thinks that a little salary should be added to the large amount of experience which has constituted the principal part of his wages.

When the experience has made the man of some possible value to the railroad company, other people are generally able to see that he is capable of earning a little more money, and the chances are that the young man will be sorely tempted to go with some car or locomotive concern or into some other business for which he is partially fitted. Generally the railroad company does not come to the rescue with an offer of a definite position attached to living wages. He is told: "Remember the experience you are getting, my boy. You stand well with the company, and if you will 'plug along' for a while, you will be duly rewarded." No doubt the railroad company means well, and knows that we will be rewarded in the next world, or, at least, recognize their good intentions.

Special apprentices should not be promoted over the heads of old employees simply because they are "*supposed* to be specially well prepared for advancement" or because the "father is a great friend of the vice-president." The fact of the matter is, however, that a man of technical education and two or three years' experience is at least worth an ordinary mechanic's wages if he is at all worth retaining in the service. "Q."

THE DAVIS COUNTERBALANCE.

To the Editors:

If ease of riding had been the only object sought in counterbalancing, the Master Mechanics' Association rules would be very different from what they are. In general, an engine can be made very faulty with any system of counterbalancing with revolving weights, if the features that are conducive to easy riding are bestowed too liberally upon the wheels. Riding qualities, moreover, depend upon so many other factors besides counterbalancing; the estimation of these qualities depends to such an extent upon the personal element, and a rational comparison of the two methods of counterbalancing is apparently so simple, that one cannot be fully satisfied unless he is shown why the Davis wheel is better than the wheels now in general use.

What is now greatly desired by all interested in counterbalancing is a demonstration founded on Newton's three laws of motion, in which the series of cause and effects is shown by logical steps so complete as to leave no room for questions between them, leading to the final effect on the engine. Does not the importance of the subject warrant Mr. C. E. Miller in *taking* time to indulge in a technical discussion of this?

Will Mr. Ira C. Hubbell explain *why* the system of forces which he describes yields the "distribution of weights necessary for a correctly counterbalanced wheel"?

How can revolving weights perfectly balance the forces of varying magnitude and direction which act on the crank pin in consequence of the motion of the reciprocating parts?

G. F. STARBUCK.

To the Editors:

I have been much interested in the discussions of the Davis counterbalance in recent issues of THE AMERICAN ENGINEER, and wish to refer to the article on page 142 of your April number over the signature of Mr. Ira C. Hubbell.

Mr. Hubbell evidently overlooks the fact that the revolving weights on a locomotive driving wheel can be, as everyone admits, and actually are, perfectly balanced, and that it is the overbalance, or that which is *added* to counterbalance the reciprocating parts, that causes the blow on the rail. He has no more right to expect a resultant between one of his counterbalances of the Davis system and the crank than he would have to expect to isolate a part of the tire or one of the spokes and get a resultant between that and the counterbalance, because all of these—tire, rim, spokes, etc.—are revolving parts, and none are more perfectly balanced than are those weights which are commonly known as the "revolving parts"

of the driver. And none of these revolving parts are instrumental in causing the hammer blow of which Mr. Fetters speaks.

To determine this hammer blow we must take the excess balance alone, considering all the rest as part of a perfectly balanced wheel. Then it is readily seen that there can be only one resultant, and that it acts, as Mr. Fetters pointed out, between the two weights, directly opposite the crank, so that the same effect is obtained with twice the weight as with the single counterbalance.

ROBERT M. CAMPBELL.

To the Editors:

Will some one who is acquainted with the theory and merits of the Davis counterbalance answer the following questions with reference to the diagram given? Let us suppose that the diagram reproduced below represents a driving wheel:

First—Is there any objection to the *revolving parts* being balanced with a weight opposite the pin as shown at R; as the revolving parts do not cause the hammer blow if balanced?

Second—Will not one-half as much weight at R balance the revolving parts as it would take if weights are located at A and B, the 120° position?

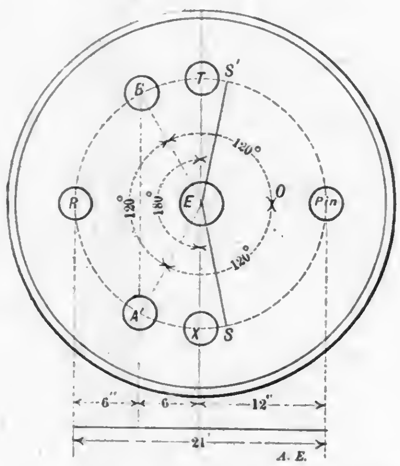


DIAGRAM OF LOCOMOTIVE DRIVING WHEEL.

Third—Is the balancing of the revolving parts with a weight at R unmechanical, mathematically incorrect or does it involve a waste of material?

Fourth—If the counterbalance weights are shifted out to the 180° position at X and T, and as suggested by Mr. Hubbell, give no hammer blow, is the wheel balanced? Is any portion of the reciprocating parts balanced? Will any addition or subtraction of an equal quantity of weight from X and T offset the balance?

Fifth—If the 120° or Davis location is correct and the weights are placed at A and B, have they not a resultant center of gravity which will fall half way between the center of the axle and the center of gravity of the weight R, as Mr. Fetters has outlined?

Sixth—Is not the real problem, in either the Davis method or Master Mechanics' method, to balance the *reciprocating parts* which exert a force which varies from nothing as the piston comes to rest at either end of the stroke to the maximum as the pin passes the top or bottom quarter, with fixed weights?

Seventh—Will fixed weights in rotation vary themselves to meet the conditions of the above problem by either system?

Eighth—Is it not a fallacy to assume that because a weight which is needed at R, under the one method, causes a hammer blow and that because two weights placed at X and T cause no hammer blow under the other method, as suggested by Mr. Hubbell, that weights placed midway between these points would both balance the *reciprocating parts* and do away with the hammer blow (remembering the increase in size needed in the Davis location in order to get a resultant equal to a weight at R, if the same proportion of reciprocating parts are to be used)?

Ninth—Is the "phenomenon" that a wheel can be balanced with weights 120° apart any greater discovery than that a fly-wheel can be built correctly with the spokes 120° apart—which is not a new discovery?

Tenth—Are there not some Davis balances so arranged that a portion of the weight comes in the 180° field *on the pin side of the wheel*, so that the edges of the counterbalance come about as the line S E S, to the pin? Is this either mathematical or mechanical?

X. Y. Z.

NEW LOCOMOTIVE SHOPS.

READING, PA.

PHILADELPHIA & READING RAILWAY.

V.

(For previous article see page 156.)

THE POWER PLANT.

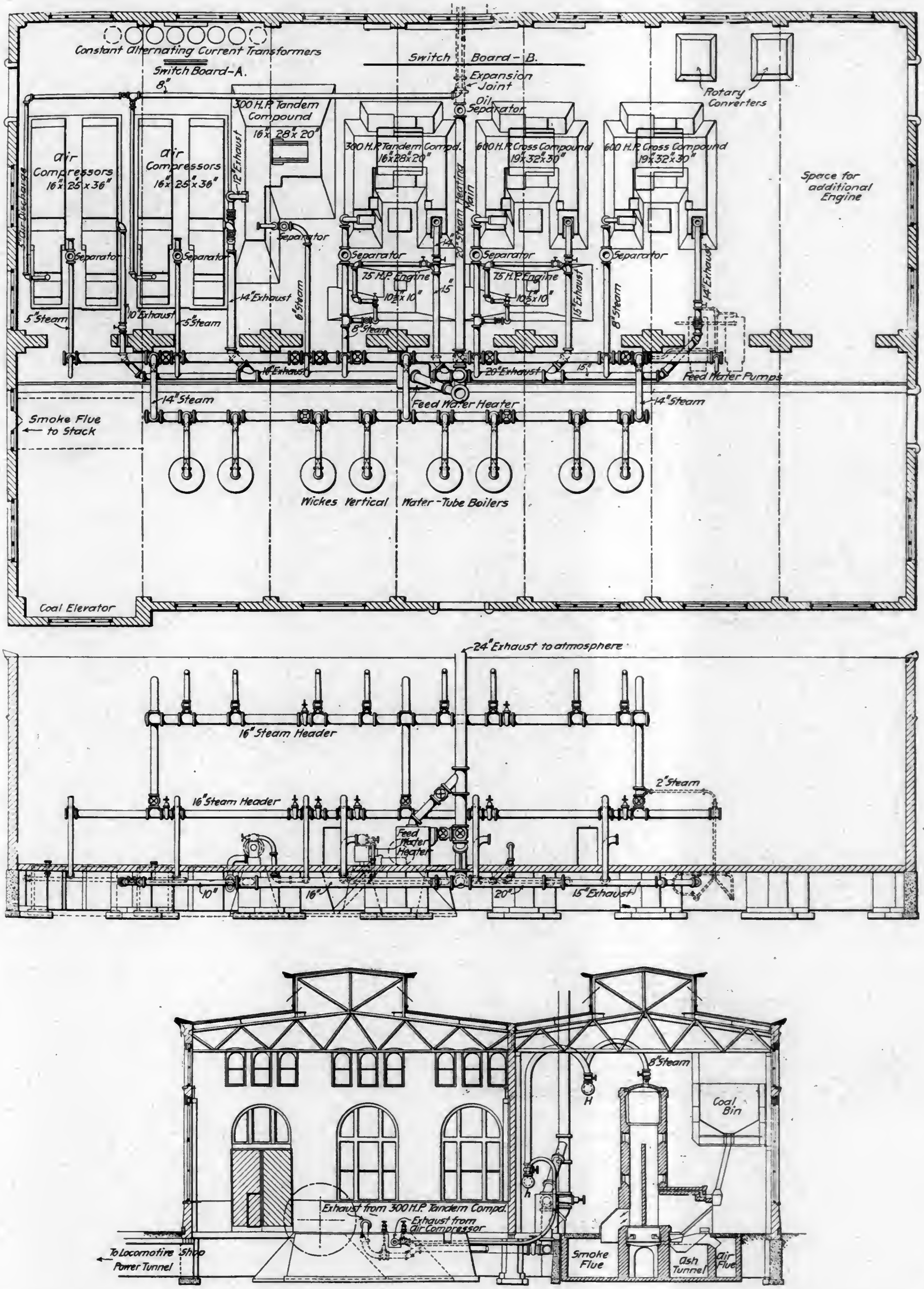
The growing importance of the part that the central power plant and the electrical method of distribution of power are playing in modern railroad repair shop installations is strikingly emphasized by the thorough and careful design and the character of the work of installation of the building and equipment of the power plant for the Reading shops. The plant that has been installed there is undoubtedly the most complete and well-equipped power plant that has ever been built for use in connection with railroad repair shop work. It is designed for a large ultimate capacity, and is intended to supply current for all classes of service—power and lighting, both arc and incandescent—to all of the departments of the railroad located at Reading. Besides supplying power and lighting for all departments of the locomotive repair shop, current will also be furnished to the car repair shops, which are located adjoining; to the depot buildings, roundhouses, freight yards; to a storehouse and to a repair plant within the city, and to a pumping station some distance outside of the city. In this way a great deal will depend upon the constancy of the service furnished by this plant, but the provisions made to prevent breakdowns are very elaborate and are not to be excelled in the very best modern power plant practice.

The power house is a substantial steel and brick building, 175 ft. long and 112 ft. wide inside, and with a clear vertical space inside of 35 ft. under the roof trusses. It is divided into two sections by a division wall, one the boiler room (50 ft. wide) on the east side and the engine room (62 ft. wide) on the west, the engine room having an 8 ft. 8 in. basement in which all the steam and exhaust piping for the engines is carried. The general arrangement of apparatus in the plant is indicated in the floor plan drawing on the opposite page, together with which is presented a cross section of the building. Two external views of the power house were presented on page 14 of our January (1903) issue, one from the west side and the other from the boiler-room side, showing the separate building for handling the ashes.

An important feature of the power plant building is the tile roof, providing the advantage of freedom from dripping moisture, inherent with all iron roofs in cold weather; also it is absolutely fireproof, there being no wood used. The roof is built up of hollow book tiles laid upon inverted T bars resting as purlins, upon the steel roof frame, and the whole is covered with slag cement. In fact, the entire building is equally as fireproof, no wood being used in any part of it except for doors and window casings.

The engine room is served by a 10-ton hand crane, all the steam piping being carried below the engine room floor to give free head-room. The crane was used very successfully from the completion of the building for installing all of the machinery. The lower portion of the engine room walls were laid to a height of 6 ft. above the floor with white tile-faced brick; this is found to very materially brighten up the room, reflecting light upon the machinery, as well as also to present a very pleasing appearance. The ventilator windows in the lantern upon the roof are opened and closed by hand control from the floor through chain and sprocket connections—a very convenient and quick method in case of a sudden storm.

The boiler room contains 8 Wickes vertical water tube boilers, set in batteries of two each, as indicated in the floor plan. Each boiler is of 250-h. p. (heating surface = 5,112 sq. ft.) capacity at the working pressure of 150 lbs. per sq. in., making



FLOOR PLAN AND CROSS SECTION OF BUILDING, AND SPECIAL SECTIONAL ELEVATION TO SHOW ARRANGEMENT OF STEAM PIPING.

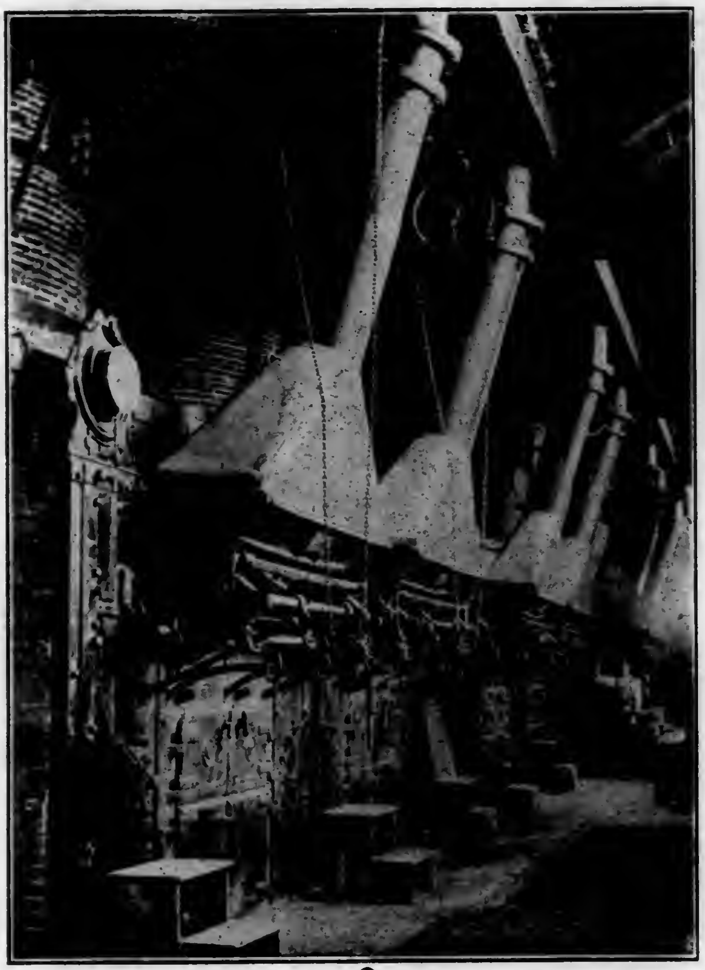
READING SHOPS POWER PLANT.——PHILADELPHIA & READING RAILWAY.

S. F. Prince, Jr., *Superintendent Motive Power.* E. E. Brown, *Electrical Engineer.*

a total plant capacity of 2,000-h. p. The boilers are fired by the well-known Roney rocking-grate stokers, which were furnished by Westinghouse, Church, Kerr & Co. Each boiler has an effective grate area of 62½ sq. ft.

The stokers are operated by two small Westinghouse engines, the drives being so arranged that each engine operates only four stokers. Extension couplings are provided for the drive shafts, however, so that in case of shut-down at either engine the other can be arranged to drive all the stokers, for which either engine has sufficient capacity. Steam engine drives were preferred to electric motors for convenience in starting. Draft is furnished both by a chimney and by a fan on the forced-draft system, the requirements calling for both an air pressure below the grate and an exhaust above.

Natural draft is furnished by a very pretty brick stack, 125 ft. high, with an inside diameter of 10 ft. This stack was built to special design by the Alphons Custodis Chimney Construction Company, New York. The connection between the boilers and the chimney is had through an 8½ ft. by 9½ ft. underground smoke flue located at the rear of the boilers, as shown in the cross-section view of the power house. The undergrate forced draft is furnished by a 10-ft. blower fan, located at the north end of the boiler room and delivering through the underground air flue shown in front of the boilers.

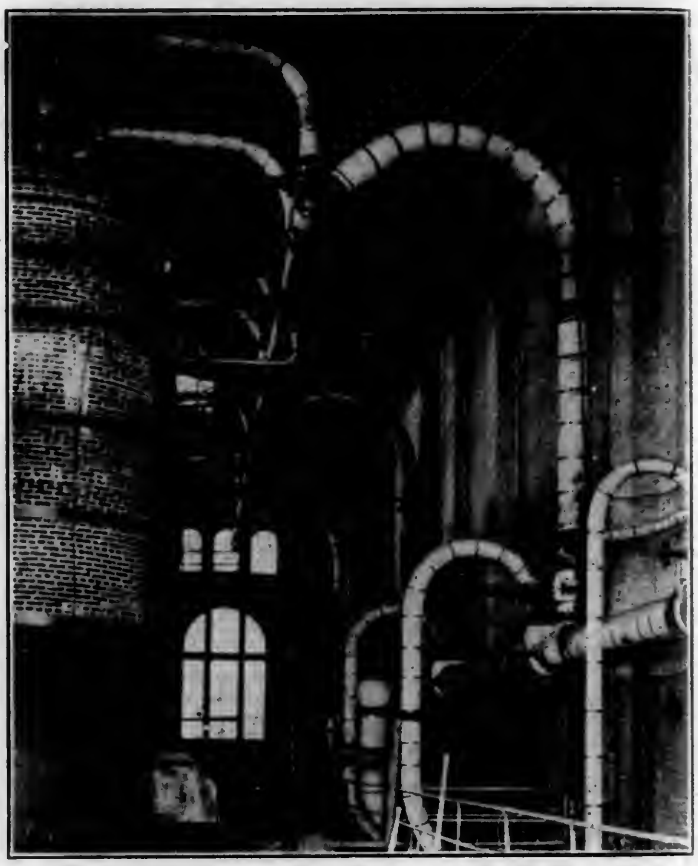


VIEW IN FIRE ROOM, SHOWING THE WICKES VERTICAL BOILERS AND THE COAL CHUTES LEADING FROM THE ELEVATED COAL BUNKERS TO THE STOKERS.

Dampers are provided at each boiler to regulate the air pressure, as well as to regulate the effect of the natural draft.

The reason that both natural exhaust draft and forced draft are used is that both were required with the stoker as installed in order to obtain the desired working efficiency of 10.5 lbs. of water evaporated per pound of combustible. The specifications call for an exhaust suction above the grate which would produce a ⅛-in. difference of level in a U-tube, and a forced draft pressure below the grate sufficient to produce a difference of level of 1 in. in a U-tube. In a test that was made shortly after the boilers were placed into service, a performance was shown of 10.6 lbs. of water evaporated per pound of combustible with the regular coal, showing under analysis 19.6 per cent. of refuse and 2.14 per cent. of moisture, and with an exhaust draft above the grate of 7-32 in. (U-tube) and a forced draft below of 9-32-in. (U-tube), the steam pressure averaging only 140 lbs. and the boilers working under only an 87.4 per cent. rating.

Coal is stored in a series of elevated hopper bins, of 300



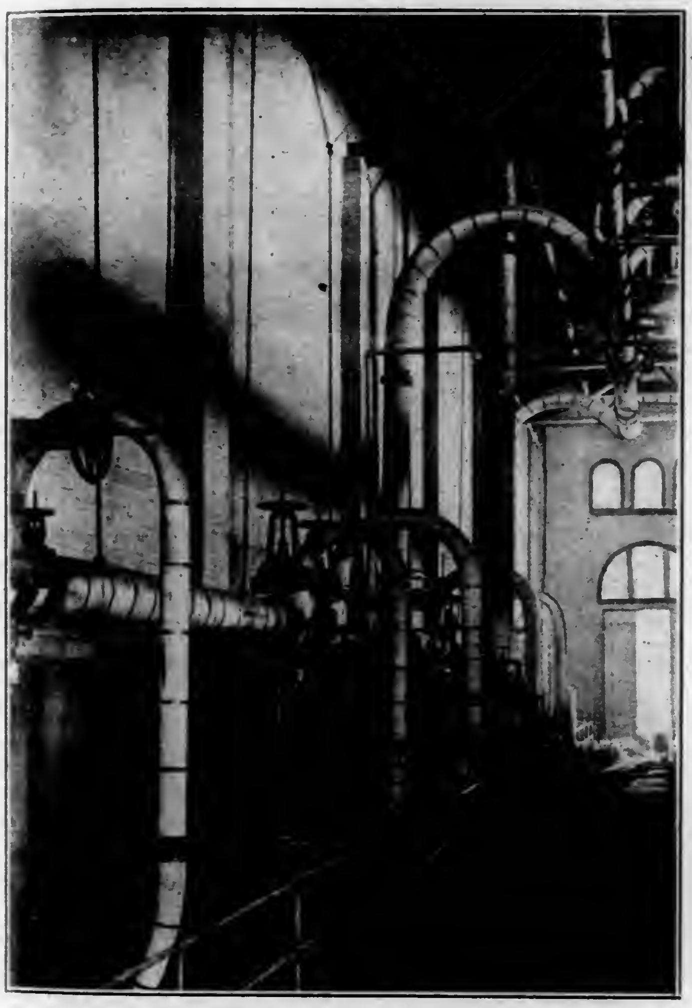
VIEW IN BOILER ROOM, SHOWING THE VERTICAL BOILERS AND THE RELATIVE LOCATIONS OF THE TWO 16-IN. STEAM HEADERS.

tons capacity, located above the fire room, from which it is delivered direct to the stokers by chutes, as shown in the cross section and also in the view of the boilers. The bins are of built-up steel construction and are supported partially from the side wall and partially from the roof trusses, which are extra heavy; this frees the fire room of obstructions. The coal is delivered into the bins by a conveyor system of a capacity of 100 tons per hour, which carries it from the receiving pit under the track at the east side of the building and distributes it, in connection with a scraper conveyor above the pockets, into any desired bin. The coal used is a buckwheat grade, containing about 20 per cent. of ash.

The ash conveyor system is entirely separate from that for the coal; it consists of a scraper line leading through the ash tunnel under the ash-dumping portions of the grates, and delivers underground into the separate ash storage building outside of the boiler room. In this ash building another elevator conveyor raises the ashes up into bins, from which they are dumped into cars for removal. The ash storage building involves an interesting construction; the bin floor slants at an angle of about 45 degrees toward the dumping, or track side, and is lined with 1-in. glass plate. This produces an absolutely non-corrosive surface, upon which the ashes slide with the utmost freedom.

The piping systems are undoubtedly the most complete and best arranged of any to be found in power plant practice. Two illustrations of the same are presented herewith to indicate the method of swing suspension of the steam headers to allow for all conditions of expansion and also to show the

partial duplicate arrangement of connections. Expansion is well cared for, being taken care of by the swing suspension and long-radius bends in all cases, except in the power tunnel, where it was found necessary to use slip joints. Duplication is almost wholly provided for by the two steam headers (marked H and h in the cross section), each of which headers are of three-quarters the size that would have been required if a single header had been used, thus ensuring ample receiver capacity. There are three 14-in. pipe connections between the two headers to permit cutting around any leak or disabled portion. Another valuable feature of the piping connections



VIEW OF STEAM PIPING SHOWING SWING METHOD OF SUSPENSION AND ARRANGEMENT OF LONG RADIUS BENDS TO MAKE CONNECTIONS ON UPPER SIDES OF HEADERS.

is that all leads from either header are taken from the top, so that no condensation is liable to be entrained but will tend to pocket in the header from which it is regularly drained.

The piping is an excellent example of steamfitting work, having been installed by the Best Manufacturing Company, Pittsburg, Pa. By-passes are included on all steam valves above 8 ins. in diameter. The live steam system is carefully arranged to avoid interruptions of service. Each boiler feeds from its steam drum directly into the upper 16-in. header, H. and the upper header delivers steam to the lower 16-in. header h. through either one, or all, of three 14-in. connections with long-radius bends. The pumps, the engines and the air compressor take steam from the lower header through 5 and 8-in. pipes as required. An interesting feature of the installation was the assumption of a cost of the entire piping at $10 per boiler horse-power in the preliminary estimate—this figure proved to be very close, tending, however, a trifle low.

The boilers are fed by Janesville boiler-feed pumps, and are protected from high and low water by Reliance whistle alarms. The feed water is heated by a Cochrane 2,000-h.p. open exhaust steam heater, through which all the exhaust steam passes on its way to shop heating or to the atmosphere.

GERMAN LOCOMOTIVE TESTS.

BY LAWFORD H. FRY.

In the Journal of the Association of German Engineers (*Zeitschrift der Vereines Deutscher Ingenieure*) for November 22, 1902, Herr von Borries reports a most interesting series of tests made on the Prussian State Railway with the latest superheater engines and four-cylinder balanced compounds. Translated extracts from this report appear on page 195 of this issue and will be found interesting in more than one direction. Not only the figures obtained, but the thorough manner in which the results are presented, deserve attention. It will be seen that in determining the horse-power developed by the locomotives, the resistance of the locomotive and tender, and the resistance of the train are calculated separately by independent formulæ and then added together to obtain the total tractive power required. This appears to be a most logical procedure and it is interesting to compare the results thus obtained with those obtained by the method usually employed in this country. The figures below show the results of comparing the Barbier formulæ, which Herr von Borries uses, with those of *Engineering News* and of the Baldwin Locomotive Works, which find general acceptance here. The formulæ, R being the resistance in pounds per ton (2,000 lbs.) and V the speed in miles per hour, are as follows:

Engineering News.................. $R = 2 + \frac{V}{4}$

Baldwin Locomotive Works .... $R = 3 + \frac{V}{6}$

Barbier (Locomotive and Tender).... $R = 7.6 + 4.6\,V\,\frac{V + 20}{1000}$

Barbier (Train)......................... $R = 3.2 + 1.55\,V\,\frac{V + 31}{1000}$

The resistance in pounds per ton for various speeds which are given by these formulæ are shown in the following table:

Speed in Miles per Hour.	Resistance in Pounds per Ton. Engineering News.	Baldwin Loco. Works.	V. Borries (Loco. and Tender).	V. Borries (Train).
10	4.50	4.67	8.98	3.84
20	7.00	6.33	11.28	4.78
30	9.50	8.00	14.35	6.03
40	12.00	9.67	18.61	7.60
50	14.50	11.33	23.70	9.48
60	17.00	13.00	29.65	11.66
70	19.50	14.67	36.58	14.16
80	22.00	17.33	44.40	16.96
90	24.50	18.00	53.14	20.08
100	27.00	19.67	62.80	23.50

It will be observed that while the German locomotive resistances are very considerably higher than the American figures, yet the car resistances are lower at all speeds below 80 miles per hour, above which speeds the application of the formulæ is somewhat problematical. Presumably the German figures are intended to give the *indicated* tractive power required—that is, the tractive power which must be developed in the cylinders to overcome the resistance of the machinery of the engine in addition to the rolling resistance, while the American formulæ are intended to give the required *available* tractive power—that is, the tractive power required at the rails to move the train exclusive of the power required to move the locomotive and machinery.

Another noteworthy point is the limit which Herr von Borries sets for the rates of evaporation and combustion, which are:

Maximum evaporation—14.5 lbs. of water per square foot of heating surface per hour.

Maximum combustion—97 pounds of coal per square foot of grate area per hour.

If these figures are compared with Professor Goss's tests of the Purdue locomotive it will be seen that while the maximum evaporation is about the same in both cases, the rate of fuel consumption in the Purdue boiler was carried to about 180

a total plant capacity of 2,000 h. p. The boilers are fired by the well known Roney rocking grate stokers, which were furnished by Westinghouse, Church, Kerr & Co. Each boiler has an effective grate area of $62\frac{1}{2}$ sq. ft.

The stokers are operated by two small Westinghouse engines, the drives being so arranged that each engine operates only four stokers. Extension couplings are provided for the drive shafts, however, so that in case of shut down at either engine the other can be arranged to drive all the stokers, for which either engine has sufficient capacity. Steam engine drives were preferred to electric motors for convenience in starting. Draft is furnished both by a chimney and by a fan on the forced-draft system, the requirements calling for both an air pressure below the grate and an exhaust above.

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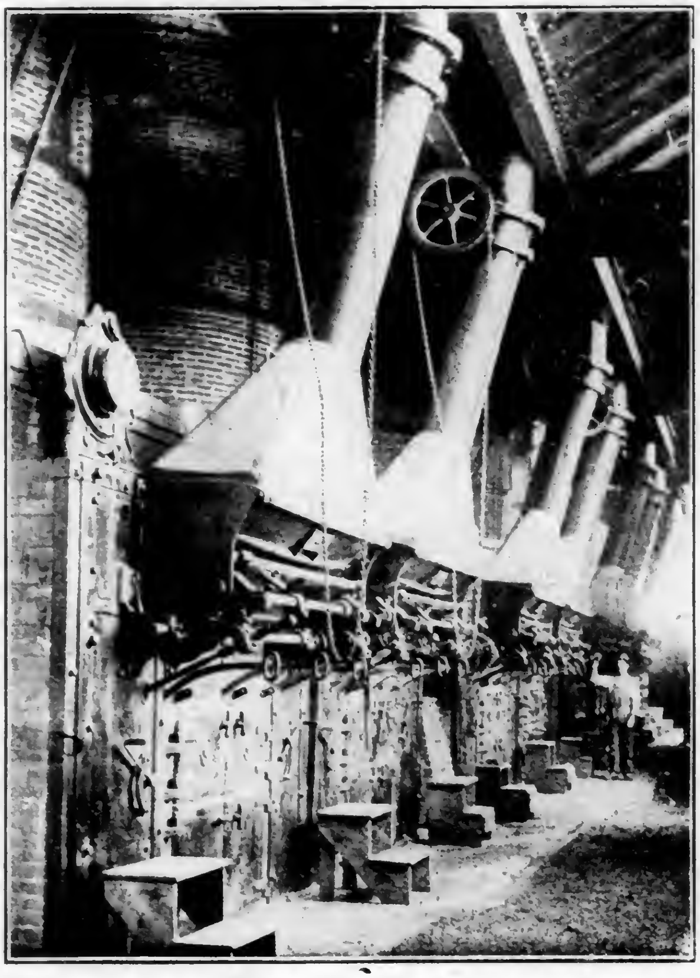

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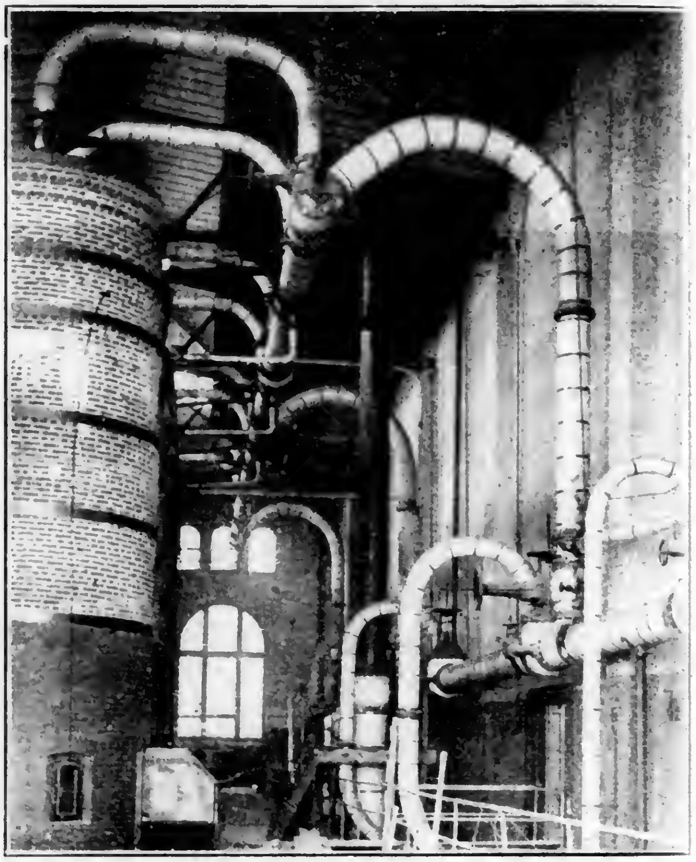

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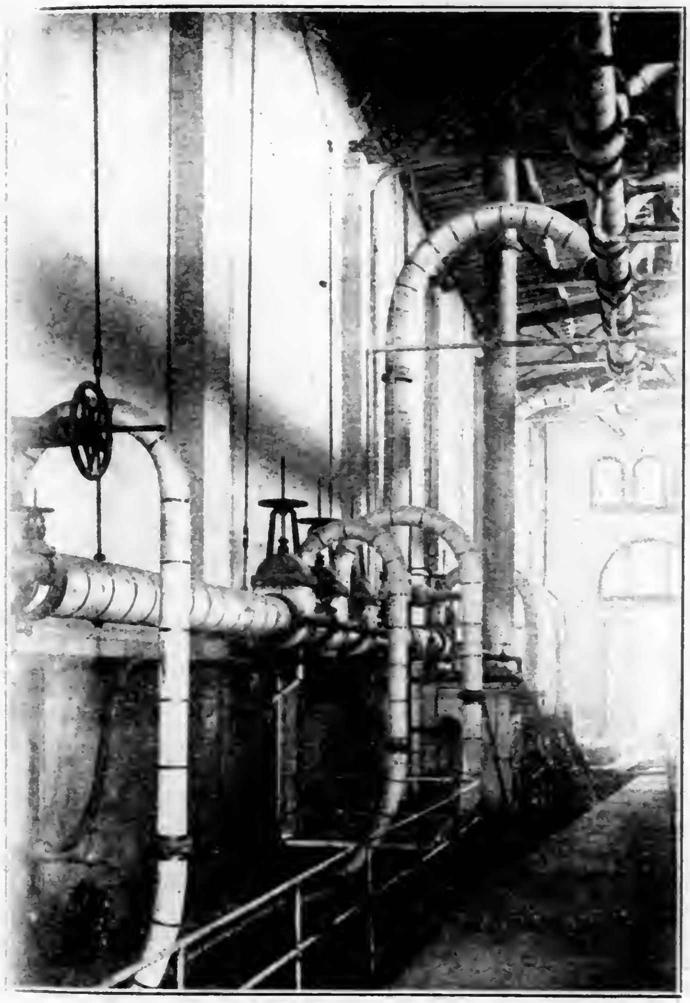

IEW OF STEAM PIPING SHOWING SWING METHOD OF SUSPENSION AND ARRANGEMENT OF LONG RADIUS BENDS TO MAKE CONNECTIONS ON UPPER SIDES OF HEADERS.

that all leads from either header are taken from the top, so at no condensation is liable to be entrained but will tend pocket in the header from which it is regularly drained.

The piping is an excellent example of steamfitting work, having been installed by the Best Manufacturing Company, Pittsburg, Pa. By-passes are included on all steam valves above 8 s. in diameter. The live steam system is carefully arranged to avoid interruptions of service. Each boiler feeds om its steam drum directly into the upper 16-in. header, H d the upper header delivers steam to the lower 16-in. header through either one, or all, of three 14-in. connections with ng-radius bends. The pumps, the engines and the air compressor take steam from the lower header through 5 and 8-in. pes as required. An interesting feature of the installation is the assumption of a cost of the entire piping at $10 per iler horse-power in the preliminary estimate—this figure oved to be very close, tending, however, a trifle low.

The boilers are fed by Janesville boiler-feed pumps, and are otected from high and low water by Reliance whistle arms. The feed water is heated by a Cochrane 2,000-h.p. en exhaust steam heater, through which all the exhaust eam passes on its way to shop heating or to the atmosphere.

GERMAN LOCOMOTIVE TESTS.

BY LAWFORD H. FRY.

In the Journal of the Association of German Engineers (*Zeitschrift der Vereines Deutscher Ingenieure*) for November 22, 1902, Herr von Borries reports a most interesting series of tests made on the Prussian State Railway with the latest superheater engines and four-cylinder balanced compounds. Translated extracts from this report appear on page 195 of this issue and will be found interesting in more than one direction. Not only the figures obtained, but the thorough manner in which the results are presented, deserve attention. It will be seen that in determining the horse-power developed by the locomotives, the resistance of the locomotive and tender, and the resistance of the train are calculated separately by independent formulæ and then added together to obtain the total tractive power required. This appears to be a most logical procedure and it is interesting to compare the results thus obtained with those obtained by the method usually employed in this country. The figures below show the results of comparing the Barbier formulæ, which Herr von Borries uses, with those of *Engineering News* and of the Baldwin Locomotive Works, which find general acceptance here. The formulæ, R being the resistance in pounds per ton (2,000 lbs.) and V the speed in miles per hour, are as follows:

Engineering News.................. $R = 2 + \frac{V}{4}$

Baldwin Locomotive Works .... $R = 3 + \frac{V}{6}$

Barbier (Locomotive and Tender).... $R = 7.6 + 4.6\,V\frac{V + 20}{1000}$

Barbier (Train)..................... $R = 3.2 + 1.55\,V\frac{V + 31}{1000}$

The resistance in pounds per ton for various speeds which are given by these formulæ are shown in the following table:

Speed in Miles per Hour.	Resistance in Pounds per Ton. Engineering News.	Baldwin Loco. Works.	V. Borries (Loco. and Tender).	V. Borries (Train).
10	4.50	4.67	8.98	3.84
20	7.00	6.33	11.28	4.78
30	9.50	8.00	14.35	6.03
40	12.00	9.67	18.61	7.60
50	14.50	11.33	23.70	9.48
60	17.00	13.00	29.65	11.66
70	19.50	14.67	36.58	14.16
80	22.00	17.33	44.40	16.96
90	24.50	18.00	53.14	20.08
100	27.00	19.67	62.80	23.50

It will be observed that while the German locomotive resistances are very considerably higher than the American figures, yet the car resistances are lower at all speeds below 80 miles per hour, above which speeds the application of the formulæ is somewhat problematical. Presumably the German figures are intended to give the *indicated* tractive power required—that is, the tractive power which must be developed in the cylinders to overcome the resistance of the machinery of the engine in addition to the rolling resistance, while the American formulæ are intended to give the required *available* tractive power—that is, the tractive power required at the rails to move the train exclusive of the power required to move the locomotive and machinery.

Another noteworthy point is the limit which Herr von Borries sets for the rates of evaporation and combustion, which are:

Maximum evaporation—14.5 lbs. of water per square foot of heating surface per hour.

Maximum combustion—97 pounds of coal per square foot of grate area per hour.

If these figures are compared with Professor Goss's tests of the Purdue locomotive it will be seen that while the maximum evaporation is about the same in both cases, the rate of fuel consumption in the Purdue boiler was carried to about 180

lbs. per square foot of grate per hour, or nearly double the amount which Herr von Borries takes as the maximum rate for the German engines. Of course, the more rapid American combustion corresponds to a higher smoke-box vacuum and a smaller amount of water evaporated per pound of coal.

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Type, 2—8—0; simple engines, cylinders, 20 x 24 ins.; driving wheels, 57 ins.; weight on drivers, 121,000 lbs.; total weight, 141,000 lbs.; weight of tender, 80,000 lbs.; total weight of locomotive and tender, 221,000 lbs.; firebox, 41¼ x 102 ins.; tubes, length 11 ft. 6 ins., diameter 2 ins., number 285; boiler diameter, 64 ins.; total heating surface, 1,856 sq. ft.; grate area, 29.6 sq. ft.; steam pressure, 200 lbs. per square inch. The diameter of the exhaust nozzle was 4¼ ins. with coal and 4¾ ins. with oil.

Special attention is directed to the large number of trips with each engine. This was an important test, from which the future policy of this road with respect to oil fuel was determined. It was therefore carefully conducted. Train No. 298 is scheduled between Mechanicville and East Deerfield, 85 miles, at 28 miles per hour with no stops. Train No. 207 is scheduled between the same stations in the opposite direction at 13 miles per hour, running time, with one stop, this being in the direction of the heavy grade. The tunnel was included in both cases and the results were not complicated by the use of helpers through the tunnel. Mr. Henry Bartlett, superintendent of motive power, has kindly supplied this information and has included the comparison of the cost of oil and fuel with the prices prevailing at the time of the tests.

COMPARISON OF OIL AND COAL FUEL.

Boston & Maine Railroad.

	Oil.	Coal.
Engine numbers	1068	1074
Train numbers	207, 298	207, 298
Trips	38	23
Cars hauled	1,079	626
Average cars hauled per trip	28.39	27.22
Tons hauled	30,481	17,982
Average tons hauled per trip	802.13	781.83
Engine miles	3.230	1 955
Average engine miles per trip	85	85
Car miles	91,715	53,210
Average car miles per trip	2,413.55	2,313.48
Ton miles	2 590,885	1,528,470
Average ton miles per trip	68,181.18	66,455.22
Gallons oil consumed	33,700	.....
Average gallons oil consumed per trip	886.84	.....
Pounds consumed	260 164	295,075
Average pounds consumed per trip	6,846.42	12,829.35
Average pounds consumed per engine mile	80.55	150.93
Average pounds consumed per car mile	2.84	5.55
Average pounds consumed per ton mile	.100	.193
Cost	$1,011.00	$458.56
Average cost per trip	26.61	19.94
Average cost per engine mile	.3130	.2346
Average cost per car mile	.01102	.00862
Average cost per ton mile	.00039	.00030

Gallon of oil weighs 7.72 lbs.
Cost of oil, 3 cents per gallon.
Cost of coal, $3.45 per ton (2,220 lbs.).
Oil test—September 17 to October 11, 1902.
Coal test, November 10 to November 29, 1902.
Test between Mechanicville and East Deerfield.

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COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

VIII.

GROUP DRIVING OF TOOLS IN THE MACHINE SHOP.

As stated in the fifth article of this series, about five-eighths of the total number of machine tools in the locomotive repair department shops at Collinwood are driven in groups from short, isolated sections of line shafting, each group having its line shaft driven by a separate constant-speed motor. The group driven tools are divided up into 17 groups of varying sizes and arrangement, according to convenience; the distribution of the groups has largely been a result of the lay-out of the tools, but it also gives evidence of an attempt to departmentize certain classes of work, such as the rod work, or the motion work, for instance. The actual arrangement of the group driven tools is indicated in the list of tools and motors for the Collinwood shops, which appeared upon pages 42 and 43 of the February (1903) issue of this journal, in which list was given not only the types and sizes of tools included in each group, but also the total power that may be required for each tool and the capacity of the driving motor that was installed to carry the aggregate load from each group.

As before stated, group driving was deemed advisable and was given the preference in the problem of powering the machine tools at the Collinwood shops. Only where important and valid reasons ruled otherwise were the tools arranged for individual drives, among which were when the tools were located under crane runways, where overhead belts and countershafts would interfere with crane service; where the advantages to be gained from the variable speeds afforded by individual driving were of sufficient weight; or where the tools are isolated, as in the boiler shop, so that the long stretches of shafting necessary would be inconvenient and wasteful of power, etc. The great majority of the tools were arranged for the group driving, including the smaller lathes, the milling machines, shapers, drill presses, turret lathes and other rapid duplicating machinery, etc.

An important feature of the group drives in this installation is that all the line shafts are driven from their motors by high-speed "silent" sprocket chains. All of the group drives in th locomotive shop, excepting the flue machinery group, are equipped with the Renold silent chain, made by the Link-Belt Engineering Company, Philadelphia, Pa.; the drive for the group of machines in the flue department, as well as for the group drives in the bolt and spring shops and for the coal conveyor, is made through the Morse rocker-joint silent chain, furnished by the Morse Chain Company, Trumansburg, N. Y. The blower and exhauster fans in the smith shops are driven by Renold chains.

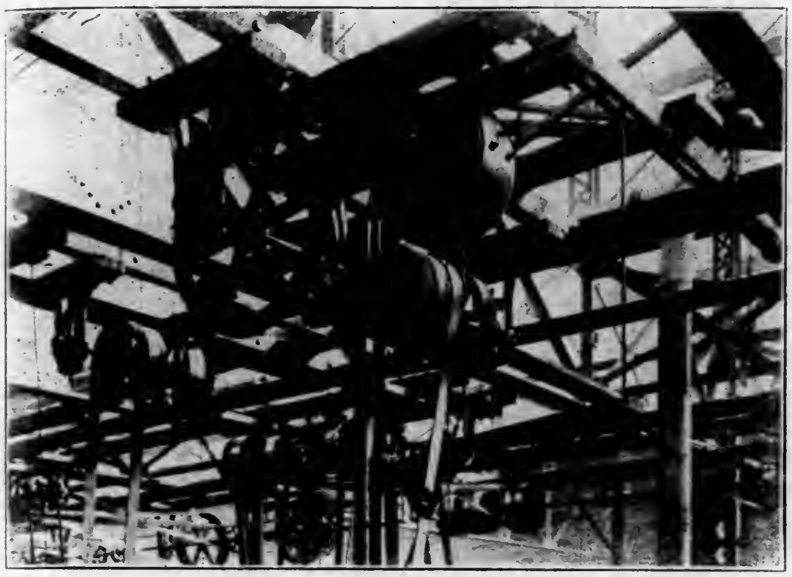
The most remarkable features of these drives are the comparatively high speed at which the chains are run, and also the closeness of centers at which the sprockets for the chains are set. The chains are in all cases operated at speeds of from 1,100 to 1,200 ft. per minute, and their sprocket-wheel centers are in most cases spaced 30 ins. apart; in the flue department group and in the blacksmith shop drives the sprocket centers are spaced slightly farther apart for convenience.

The great advantages of the chain drive are the positiveness of drive, which characterizes gear driving, and the possibility of running at high speeds without the disagreeable noise attending gear drives or drives using the ordinary sprocket chain when operated at high speeds; thus all the advantages of gear driving are retained and the advantage of much greater flexibility added.

As is well known, the silent chain consists of stamped links or bars of steel pivoted together into a multiple chain. The Renold chain uses a shouldered solid stud for pivoting, while the Morse chain builds up the links upon frictionless rocker-joint pivots. Besides permitting high speeds without excessive

noise, these chains do not require the sprockets to be set at fixed distances or short centers. They run with a smooth action and are not affected by wear or stretching, as the chain merely rides higher upon the sprocket teeth after stretching. Excessive journal friction is absolutely avoided, as these chains are always run slack. They are also not affected by excessive heat or by dampness.

The engravings, presented below, illustrate typical chain



TYPICAL ARRANGEMENT OF CEILING MOTOR FOR GROUP DRIVING. LIGHT TOOL SECTION OF MACHINE SHOP.

drives, one presenting a view of one of the ceiling constant-speed motors driving a line shaft in the machine shop, and the other a chain drive for a machine tool, in both of which cases the Renold chain is used. The close spacing between centers of sprocket wheels is made very noticeable in these drives.

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The drawing reproduced in the engraving upon page 188, indicates an interesting arrangement of the motor and the manner of supporting it, for the group-drive in the bolt shop, in the blacksmith shop building. In this case the line shaft, as well as the motor support, are located upon a side wall. The motor is supported by a very substantial bracket, built up of structural shapes and steel plate as indicated and attached to the wall by substantial through bolts passing through and bearing upon angles at the opposite side in order to distribute the pressure. The motor is located at the outer

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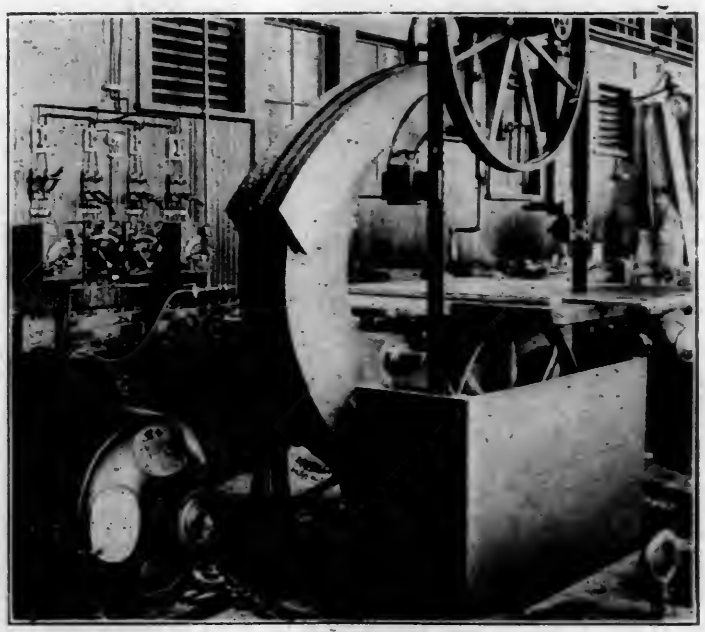

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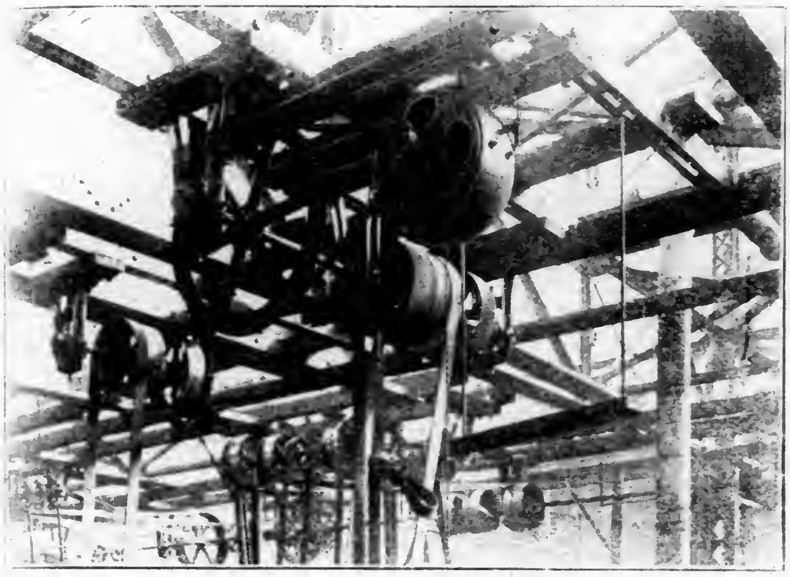

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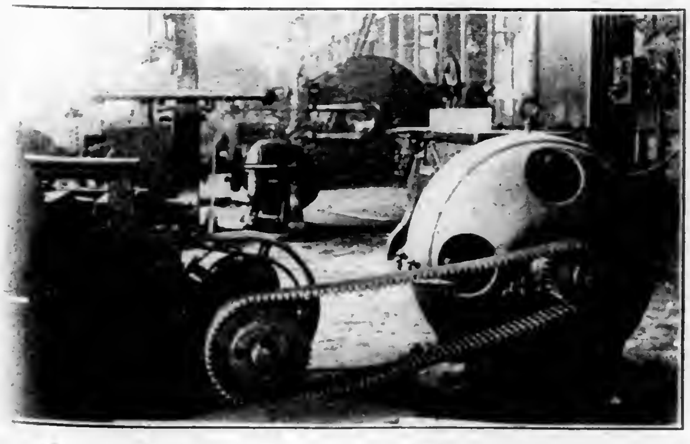

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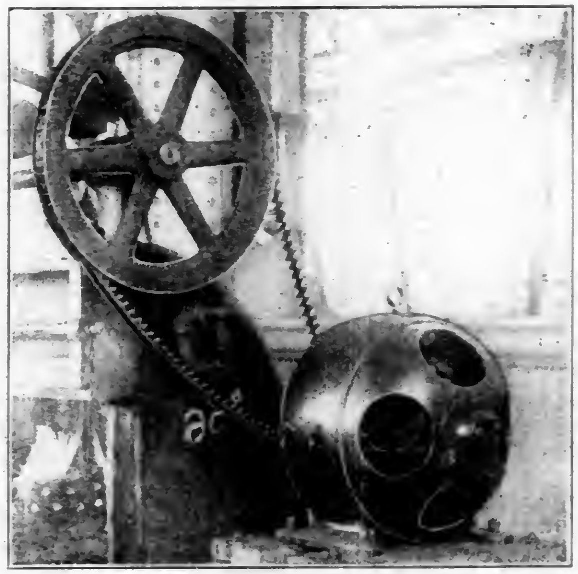

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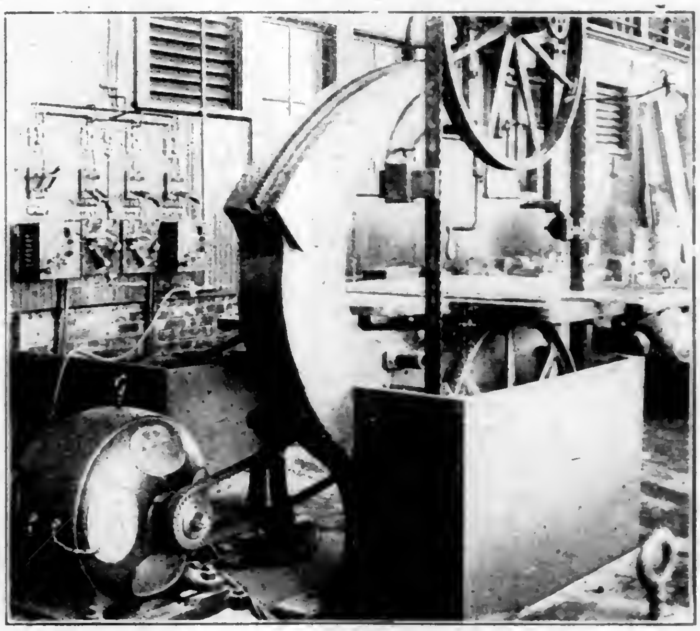

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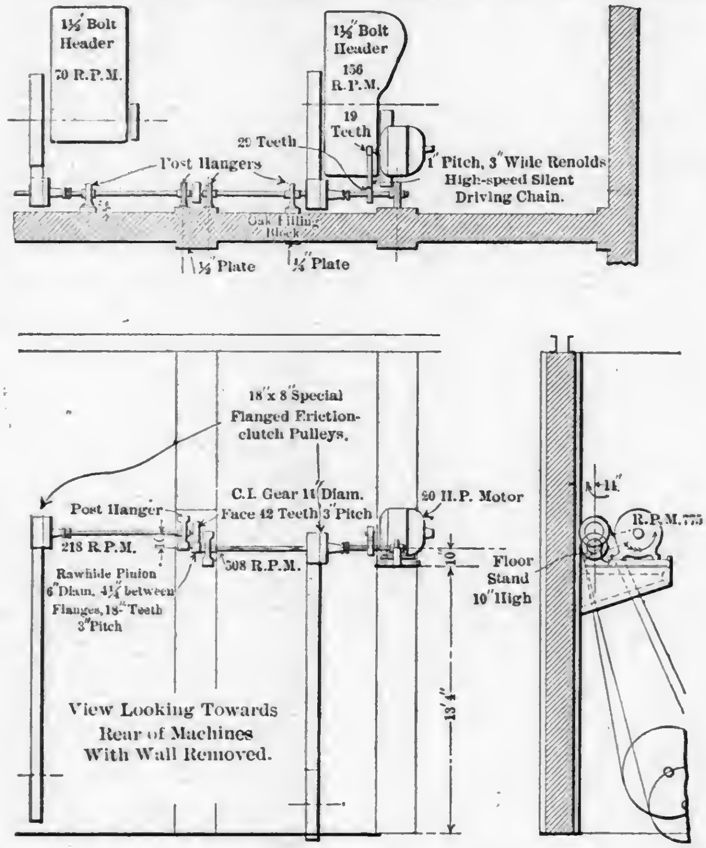
bers to accommodate the countershafting supports. The lower trusses are divided up into panels approximately 11 ft. square, so that all countershafting supports used in the machine shop are of the same length, irrespective of which direction they run; this greatly facilitated the getting out of the counter-



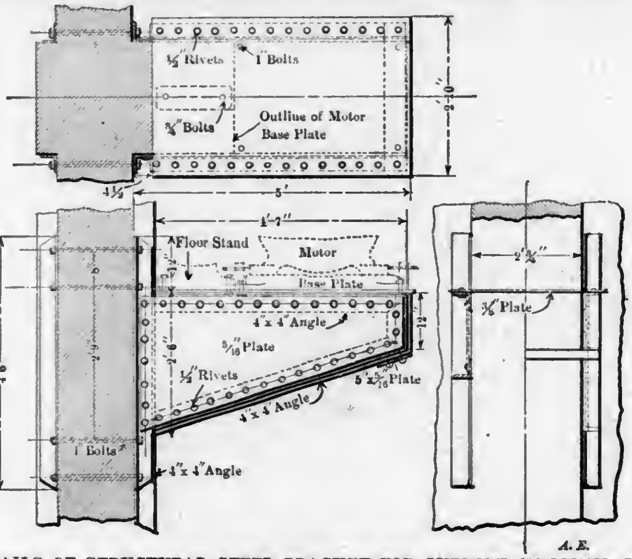
ARRANGEMENT OF A GROUP DRIVE IN THE BOLT SHOP, SHOWING METHOD OF MOUNTING MOTOR UPON A SIDE-WALL BRACKET.

shafting supports, and furthermore makes them interchangeable in case of possible future alterations. In the heavy tool section, this intermediate truss work is, of course, omitted, as the crane service there prevents shafting being used.

MOTOR DRIVEN TOOLS IN THE MACHINE SHOP.

A few more representative examples of motor-drive applications to the machine tools in the machine shop are presented herewith. The machines shown here appear well chosen to indicate the sturdy and substantial character of the tools selected for the Collinwood equipment—the effort appears to have been, and rightly so, to obtain the greatest possible production by the use of the new high-speed tool steels and machine tools strong enough to "pull the heavy cuts," rather than to economize by the use of lighter or old tools. An instance of the saving effected in one direction by this policy is to be had in the increased number of driving tires which are now bored per day as compared with previous practice. Where formerly only about three tires were bored per day of ten hours, now with the new tool steel and the heavy boring mill from seven to eight tires are bored and finished complete per day, including time of placing on table, setting and removing.

The machine tool upon which the above operation is performed is one of the 84-in. Niles boring mills, with two heads, which is driven by a 10-h.p. multiple voltage motor. The tires in question were 56-in. Midvale driving tires, and the cut was taken at a cutting speed of 19 ft. per minute and at a feed of 3-16-in. per revolution of the table, the depth of cut varying with the tire. The tool steel used was the Styrian brand of air-hardening steel. When beginning boring, the roughing tool, carried by one of the two heads, is started first and run down with a heavy cut for about 1½ ins., after which the finishing tool, carried by the other head, is started in and the two are then operated together.



DETAILS OF STRUCTURAL STEEL BRACKET FOR SUPPORT OF MOTOR IN BOLT SHOP GROUP DRIVE.

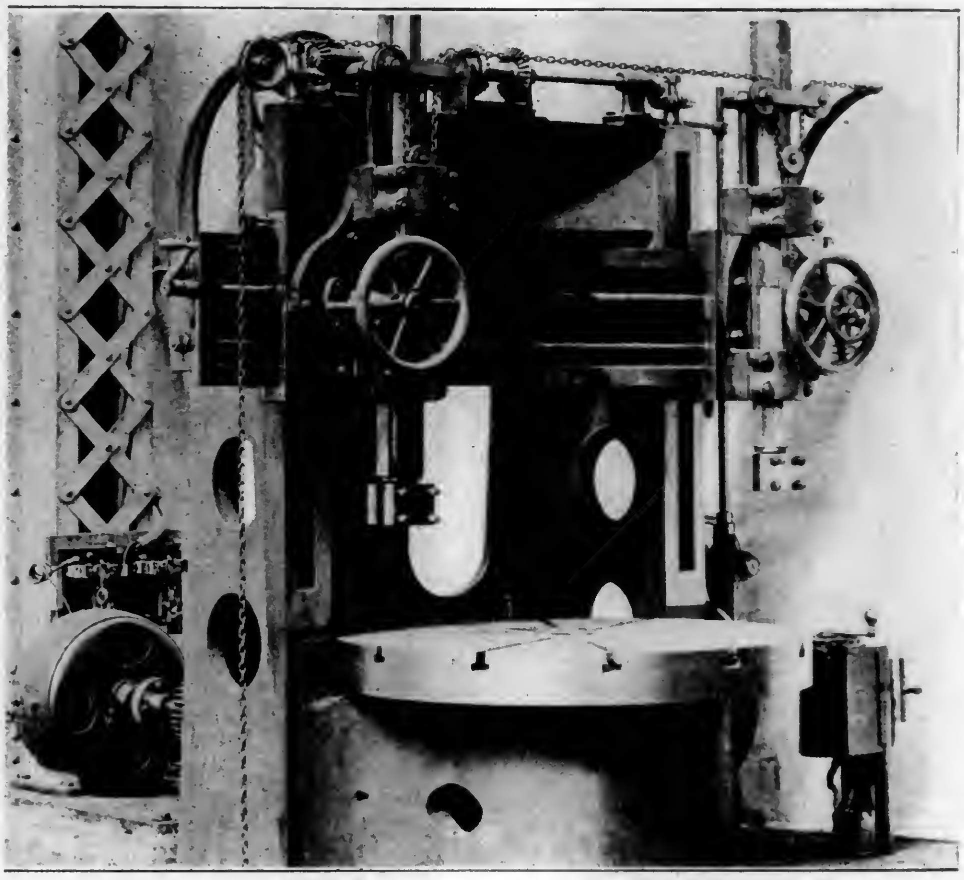
The illustration on page 189 presents a view of the 51-in. boring mill (tool No. 9 of the Collinwood tool list), which was furnished by the Niles Tool Works Company. The drive for this tool is from a 7½-h.p. Crocker-Wheeler multiple-voltage motor, through a gearing reduction, as shown at the rear of the machine. The circuit-breaker for the motor is located at the rear of the machine, so that in case it is opened the operator cannot lean over and throw it in. He has to walk some little distance—this is intended to call his attention to the fact that the main switch must be opened before the circuit-breaker is thrown in; it serves to remind him that he must not throw in the circuit-breaker without opening the switch.

A number of tools were furnished for the equipment of

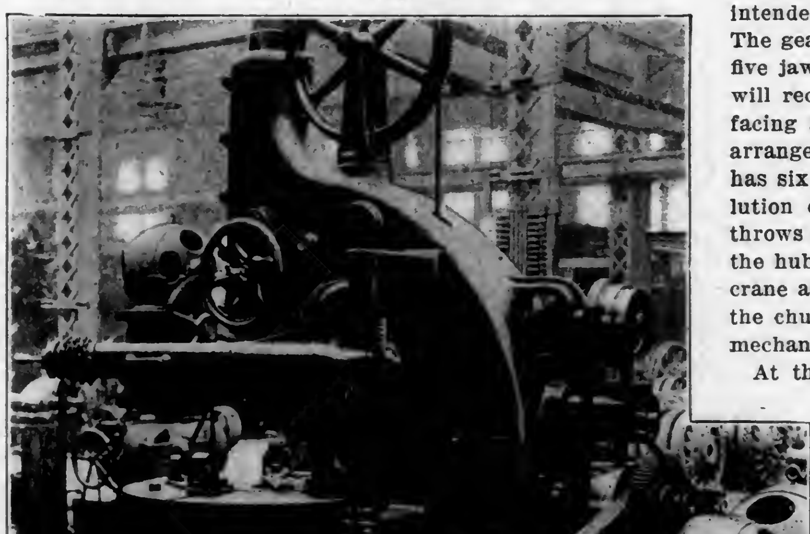
48-IN. RADIAL DRILL.—PRENTICE BROS. CO.
DRIVEN BY A 3-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RY.

these shops by Prentice Bros. Company, Worcester, Mass. One of them, a 48-in. electrically driven radial drill, is illustrated in the accompanying engraving, page 188. This machine (tool No. 42) is driven by a 3-h.p. constant-speed Crocker-Wheeler motor, which is connected to the cone shaft by two trains of gears running in opposite directions for reversal. These gears drive the cone shaft through friction clutches which are controlled by a lever from the front of the machine, so that by it the machine may be instantly stopped, started or reversed. The gears are heavy and well proportioned. Eight changes of speed are available at the drill spindle by means of the four-step cone pulleys and the back gears, and also geared variable-speed feeds are provided, furnishing eight changes of feed from .0057 to .0540 in. per revolution of the spindle.

An important feature of this machine is the arrangement of the arm upon ball bearings, in order to swing easily, and also the vertical adjustment of the arm by power. The spindle of this machine has an improved quick return and stop motion, by which the point of the drill may be quickly moved down to the work and then thrown in on the power feed—all while the machine is in operation. The feed is automatically released when the spindle reaches its lowest position, preventing damage to the gears. Among the other machine tools furnished to the Collinwood machine shop by the Prentice Bros. Company, besides the above-mentioned drill, are a 30-in. swing drill, a 24-in. drill, a 21-in. drill, eight 21-in. swing engine lathes and nine 16-in. engine lathes, all of which were handled through their Cleveland selling agents, the Strong, Carlisle & Hammond Company.



51-IN. BORING MILL.—NILES TOOL WORKS CO.
DRIVEN BY A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



48-IN. CAR WHEEL BORING MACHINE.—PUTNAM MACHINE CO.
DRIVEN BY A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The machine illustrated below is the 48-in. car-wheel boring machine (tool No. 77), which was furnished by the Putnam Machine Company, Fitchburg, Mass. This machine is driven by a 7½-h.p. multiple-voltage motor, the controller for which is located at the right-hand side of the tool convenient to the operator.

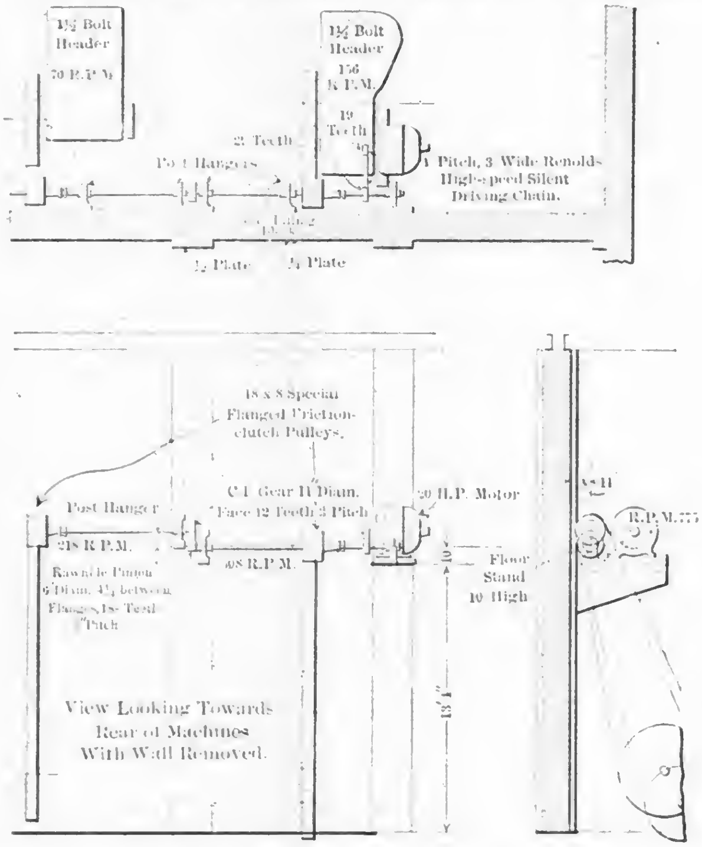
This machine is from a new and extremely heavy design, intended to adapt it to the heavy duty self-hardening steels. The gearing is of ample strength throughout. The chuck has five jaws, operated either universally or independently, which will receive wheels from 15 to 48 ins. in diameter. The hub facing attachment is independent of the main spindle, being arranged to work automatically with the spindle. The spindle has six changes of feed, varying from 3-16 to ⅝ in. per revolution of the chuck, and also has an automatic stop which throws out the feed after the boring cutter has passed through the hub. An important feature of this machine is the power crane at the side of the machine for swinging wheels up onto the chuck; this is conveniently handled by a lever and speed mechanism at the front of the machine.

At the top of the following page is illustrated the 37-in. boring mill, two of which (tools Nos. 71 and 72) were furnished by the Bullard Machine Tool Company, Bridgeport, Conn. They are belt-driven by 5-h.p. constant-speed motors, the necessary speed changes being obtained by belt and five-step cone pulleys.

This machine has two swivel heads, which are entirely independent in their movements both as to direction and amount of feed. Either head can be set at any angle and can be brought to the center for boring. The feeds, which are positive gear-driven, have ten changes ranging from 1-32 to ¾-in. horizontally and from 1-50 to ½-in. in angular and vertical directions. The cross rail is raised or lowered by power.

The engraving on page 190 illustrates the 42-in.

bers to accommodate the countershafting supports. The lower trusses are divided up into panels approximately 11 ft. square, so that all countershafting supports used in the machine shop are of the same length, irrespective of which direction they run; this greatly facilitated the getting out of the counter-



A. E.

ARRANGEMENT OF A GROUP DRIVE IN THE BOLT SHOP, SHOWING METHOD OF MOUNTING MOTOR UPON A SIDE-WALL BRACKET.

shafting supports, and furthermore makes them interchangeable in case of possible future alterations. In the heavy tool section, this intermediate truss work is, of course, omitted, as the crane service there prevents shafting being used.

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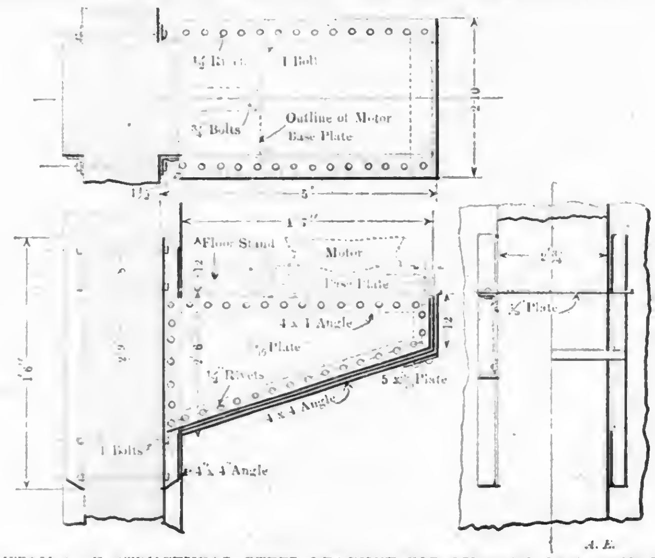

A. E.

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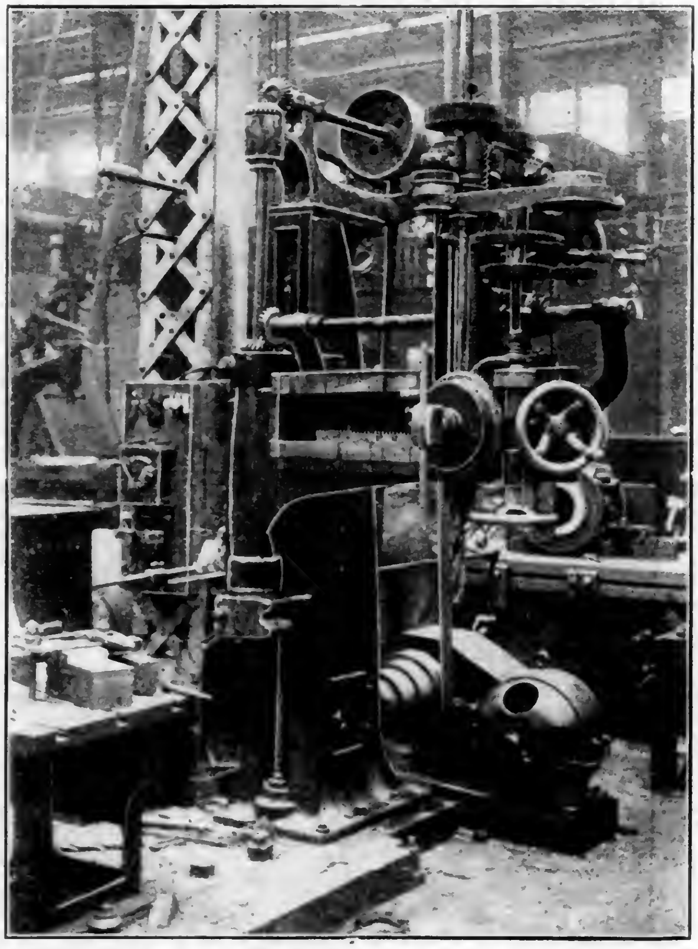

48-IN. RADIAL DRILL.—PRENTICE BROS. CO.
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COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RY.

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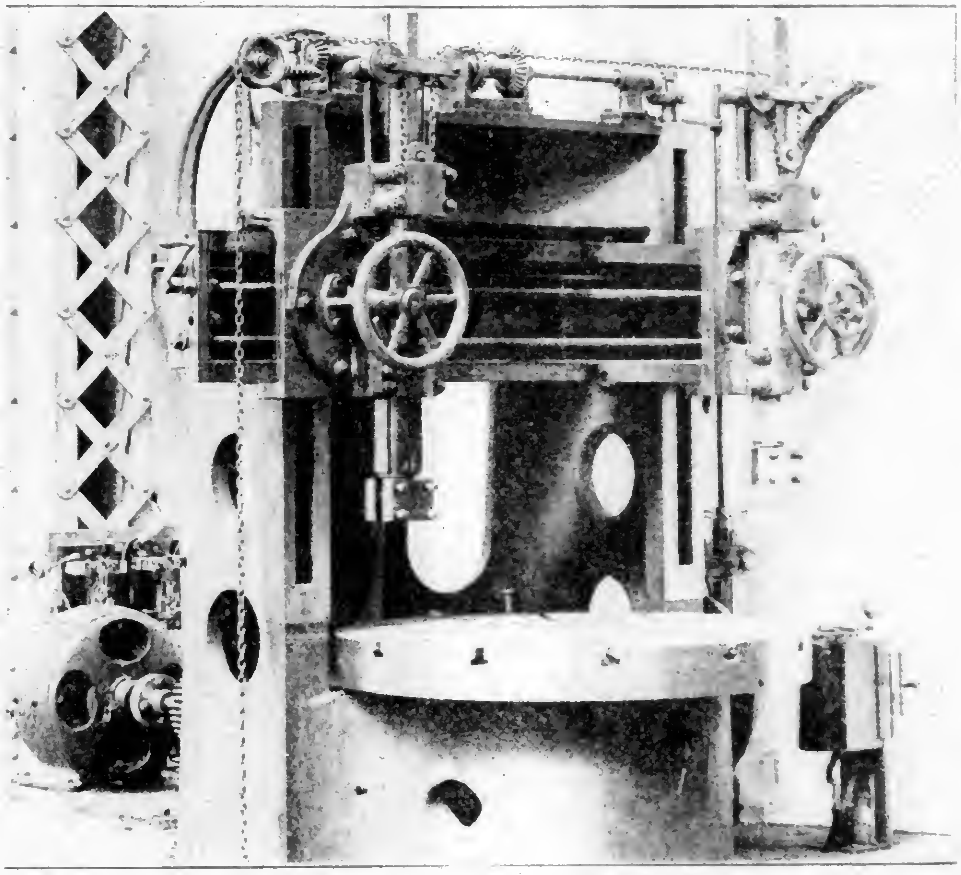

51-IN. BORING MILL.—NILES TOOL WORKS CO.
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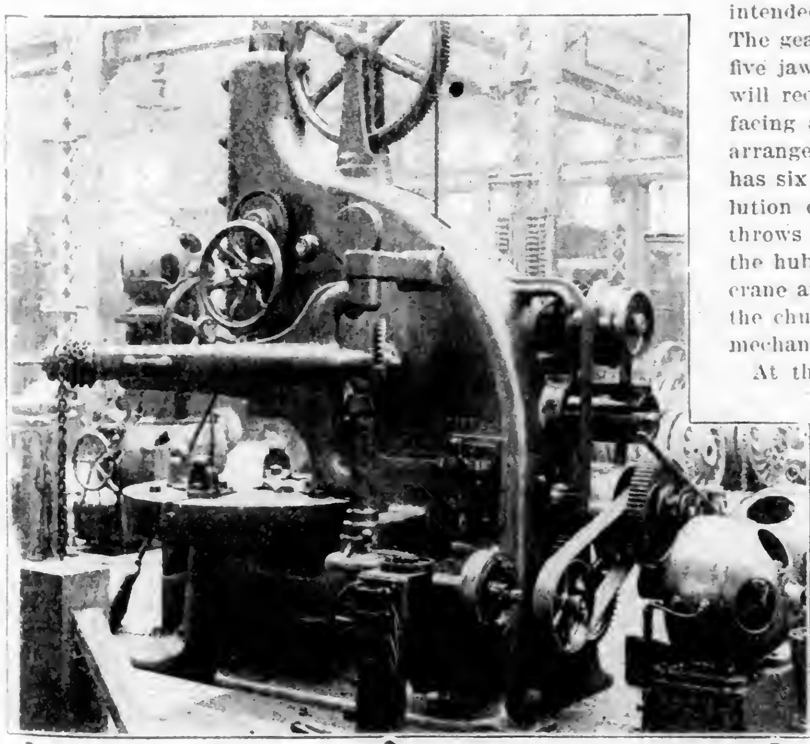
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



48-IN. CAR WHEEL BORING MACHINE.—PUTNAM MACHINE CO.
DRIVEN BY A 7½-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.
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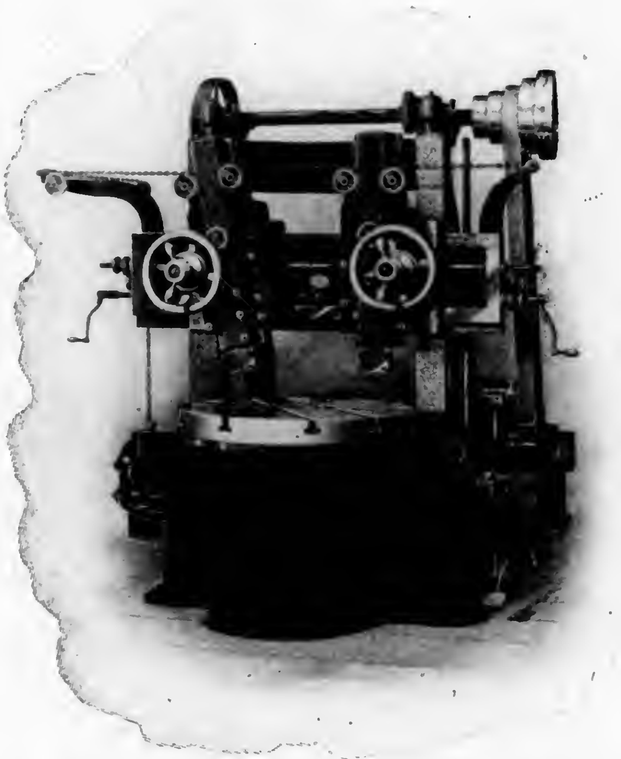
The engraving on page 190 illustrates the 42-in.

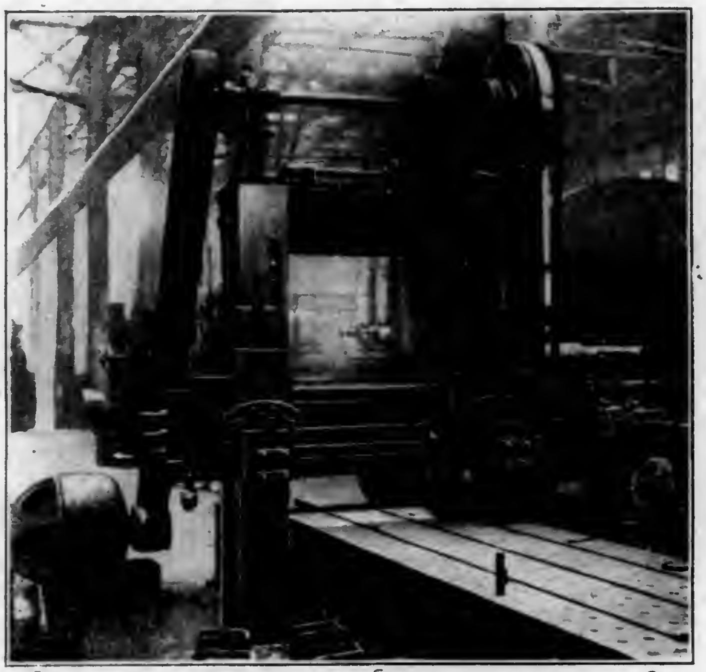
x 42-in. x 12 ft. motor-driven planer (tool No. 46) built by the G. A. Gray & Co., Cincinnati, O. It is driven by a 15-h.p. multiple-voltage motor, the motor operating the planer through a belted drive to the countershaft pulley; the arrangement shown is what is designated as the "motor-belted" type of drive by the G. A. Gray Company.

This planer has a table drive of the spur gear type, and is

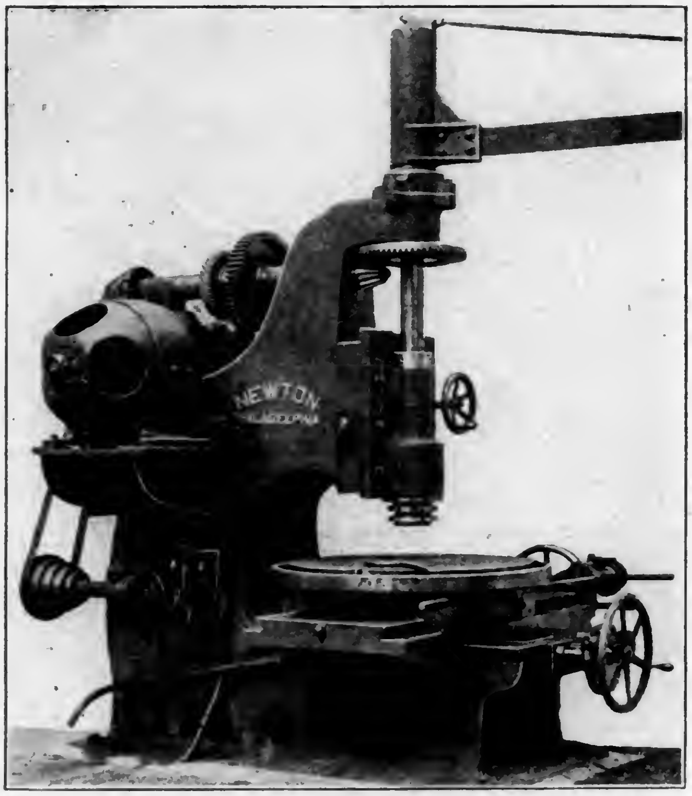


37-IN. BORING MILL.—BULLARD MACHINE TOOL CO.
DRIVEN BY A 5-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.

arranged for raising and lowering the cross rail by power. The table has two pairs of independent dogs, the extra pair on the rear side of the table, operating with an extra belt shifter lever; hinged to each shifter lever is a special trip which may be lifted when it is desired to run the table forward without disturbing the rear dog. In this way the work



42-IN. X 42-IN. X 12-FT. PLANER.—THE G. A. GRAY COMPANY.
DRIVEN BY A 15-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.



VERTICAL SPINDLE MILLING MACHINE.—NEWTON MACHINE TOOL CO.
DRIVEN BY A 10-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

may be set and the cut started complete from either side of the planer.

The engraving above illustrates the No. 3 vertical spindle milling machine (tool No. 20) which was furnished by the Newton Machine Tool Company, Philadelphia, Pa. It is driven by a 10-h.p. multiple-voltage motor, the controller not being shown. An interesting motor support bracket is used upon this machine; it is of cast-iron bolted to the side of the machine's frame. The recess beneath the bracket furnishes a convenient receptacle for the resistance box used in connection with the motor control.

PLATE BENDING ROLL.—HILLES & JONES.
DRIVEN BY A 10-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

The bending roll (tool No. 84), illustrated above, is the No. 2 plate roll made by Hilles & Jones, Wilmington, Del. It is driven by a 10 h. p. multiple-voltage Crocker-Wheeler motor through cut gears, as shown. The motor is mounted upon an extension of the bed, in front of which is located the controller.

This method of driving a bending roll is found very convenient, inasmuch as the rolls can so easily be reversed by the controller. The rolls are driven through steel pinions, and the back housing is hinged to permit removing plates after having been rolled to full circles.

THE CONSTRUCTION OF SEAMLESS BOILERS.

BY O. LENTZ, C. E., DÜSSELDORF, GERMANY.

At the recent Düsseldorf Exhibition, in the pavilion of the Rheinische Metallwaaren und Maschinen Fabrik, the products of the Ehrhardt hydraulic pressing process were exhibited. These works were established in 1889 by Mr. Ehrhardt, and now, with their supplemental works, employ more than 6,000 hands.

The Ehrhardt process, patented by the inventor in 1891, consists essentially in simultaneously punching and shaping metal blocks. To produce a hollow cylinder, a square piece of red-hot steel (a, Figs. 1 and 2) is placed in a matrix (b). The cross-section of the steel block, measured diagonally, corresponds to the diameter of the matrix. The latter is then closed by the lid d, serving as a guide for a mandrel (c), which is driven into the metal by means of a powerful hydraulic press. The diameter of the mandrel is chosen so that the material forced aside by it is exactly sufficient to fill the four segment-shaped spaces (e) between the square sides of the block and the interior surface of the matrix. Thus it is possible to work upon the minimum amount of metal necessary for the production of the piece under consideration.

If R be the radius of the matrix, the radius (r) of the mandrel is found by the formula:

$$\pi r^2 = \pi R^2 - 2R^2$$
$$r = 0.603R.$$

As the metal while being acted upon can give way at the sides, the mandrel enters the metal without great difficulty, and a hollow cylinder with closed bottom, as shown in Fig. 3, is produced; the bottom has naturally the shape of the head of the mandrel (c). This hollow body can be drawn out anew in order to produce tubes with thin walls. In the same way hollow bodies with square sections may be manufactured, which are punched in a corresponding matrix, the blocks constituting the inscribed circle of the rectangular section of the square to be produced. Blocks of irregular sections may be punched and shaped in quite the same way, there being, however, the necessary condition that the piece of metal be centered by the matrix, and that sufficient space be left for receiving the material pressed away by the mandrel. In pressing, such an amount of friction is produced against the walls of the matrix that the pressure of the mandrel on the block is proportionately small, and only a slight longitudinal compression of the material is effected.

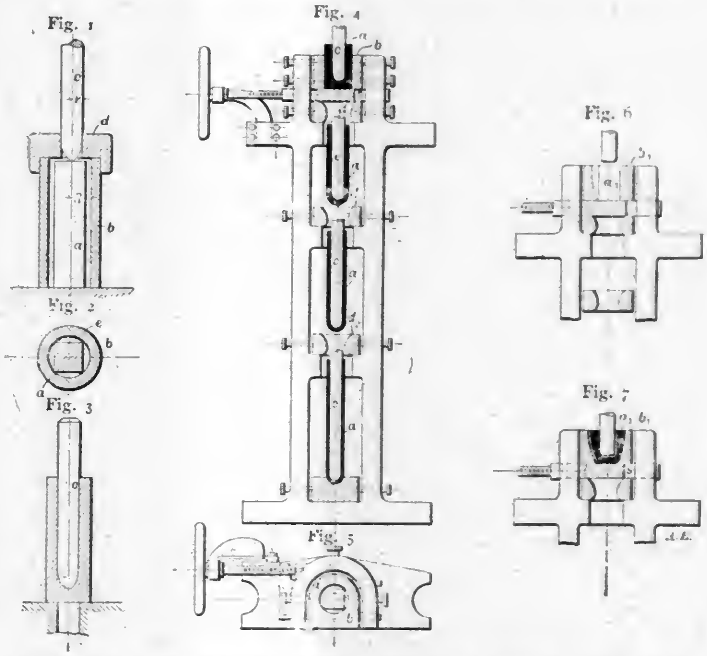
Figs. 4 to 7 illustrate apparatus for producing hollow tubular bodies, starting from a blank (a) of any shape. This blank is first punched by means of a mandrel (c) in a die (b) the bottom of which is formed by a slide (s) which is moved horizontally in the die by a screw-spindle and hand-wheel. After the metal blank in the die has been perforated as described, the slide s is withdrawn, the mandrel is moved downward together with the tubular body and presses together with the latter successively through the drawing rings d, d_1, d_2, until the tubular body has acquired the requisite thickness. The punching may also be effected by means of a short steel cylinder and a matrix of a special shape, wider at the top than at the bottom (Figs. 6 and 7).

The precision with which objects of determined dimensions are produced, and also the smoothness and polish of their surfaces, are remarkable. It is, for example, possible to make base-chamber shrapnels with walls only 2 mm. (0.0787 in.) thick, without the necessity of any machining inside.

In order to produce long weldless hollow bodies—tubes, for instance—the blank, after being perforated, is gripped by the pincers of a draw-bench and drawn out, during which operation the direction of movement remains the same. Thick tubes can thus be drawn out three times successively without it being necessary to heat the body after each operation. It is therefore possible with one heating only to produce a tube of great length.

When the thickness of the walls does not exceed 3.5 mm. (0.138 in.) the tubes are generally calibered by cold drawing on a solid bar. A red-hot temperature is very suitable for all these operations, and need not be exceeded. The perfection of the machinery at present employed allows the producing of weldless tubes with a precision of diameter or thickness of 0.1 mm. (0.0039 sq. in.). The mandrel being exactly centered and precisely guided, continues to advance without deviating when the movement has once been correctly started. The manufacture of steel flasks for highly compressed gases particularly serves to illustrate the valuable qualities of press work. These flasks, which are made in all sizes, are tested before being officially accepted, by a pressure test made as follows: The flask is filled with water and carefully weighed, then subjected to a pressure of at least 250 atmospheres. A steel band laid around the flask serves to determine the expansion resulting from this test. If it indicates no permanent deformation, the flask is accepted.

In consequence of the pressure operation the strength of



APPARATUS FOR FORMING HOLLOW TUBULAR BODIES FROM THE SOLID BLOCK.

the metal is materially increased; the walls of the flask show an equal solidity and a great tenacity in all parts, so that it can stand a pressure above 500 atmospheres. At a still higher pressure the flask does not break up into fragments, but only splits open at one place. The metal employed must possess a tensile strength 32 to 100 kg. per sq. millimeter, and an elongation of 15 to 30 per cent. After the operation it is found that not only the tensile strength, but also the elongation, has materially increased.

Practical experience has clearly proved the superiority of the Ehrhardt weldless tubes over the best welded tubes for water-tube boilers with thin tubes. For this several reasons are given: First, the metal employed is carefully chosen from among the best products of the Martin furnace, for in order to be able to stand this pressure operation it must be exempt from all defects resulting from casting; furthermore, the cherry-red heat at which the work is performed makes annealing superfluous and thus avoids its detrimental consequences. As there is no weld seam, the inner surface of the object shows no unevenness. The expansions and contractions which occur in the fireboxes of boilers take place in a regular manner, while a weld-seam, though as perfect as possible, breaks the homogeneousness of the metal and constitutes the primary cause for dislocations under the influence of varying temperatures. To this cause of inferiority must be added the difficulty experienced in obtaining an irreproachable seam. Lastly, the quality of the material employed for the seamless tubes allows of their being thickened up by upsetting, enlarged by bell-mouthing, or fitted with collars, etc., under the press, which

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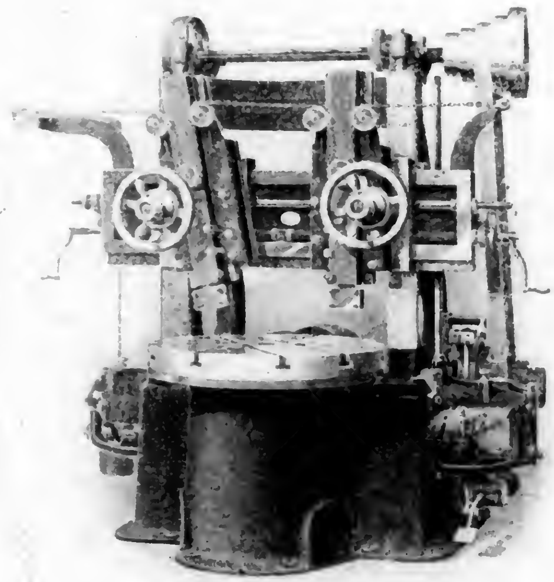

37-IN. BORING MILL.—BULLARD MACHINE TOOL CO.
DRIVEN BY A 5-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR

arranged for raising and lowering the cross rail by power. The table has two pairs of independent dogs, the extra pair on the rear side of the table, operating with an extra belt shifter lever; hinged to each shifter lever is a special trip which may be lifted when it is desired to run the table forward without disturbing the rear dog. In this way the work

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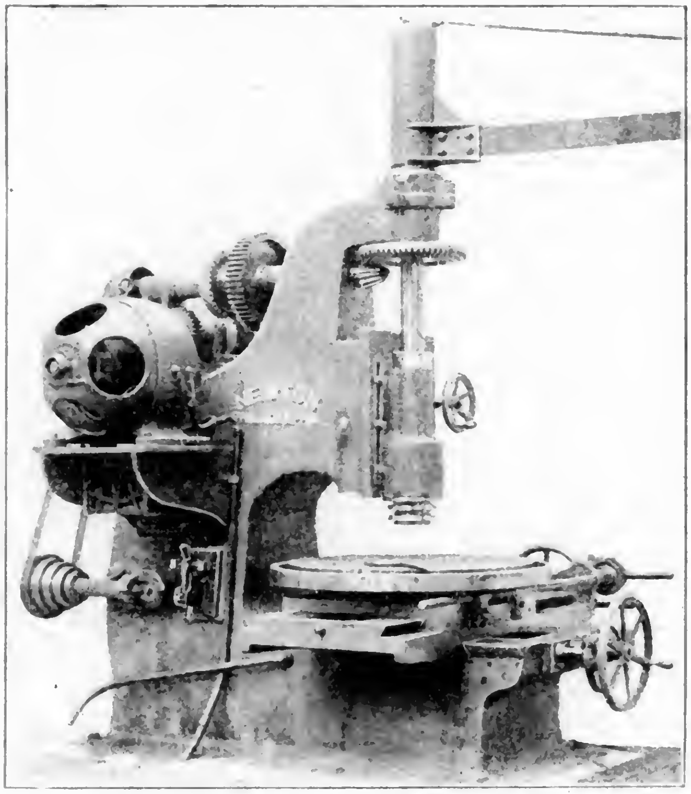

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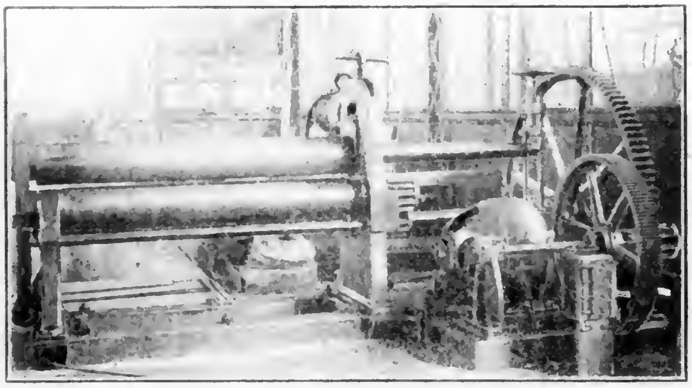

PLATE BENDING ROLL.—HILLES & JONES.
DRIVEN BY A 10-H.P. MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.

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t the recent Düsseldorf Exhibition, in the pavilion of the .mische Metallwaaren und Maschinen Fabrik, the products the Ehrhardt hydraulic pressing process were exhibited. ese works were established in 1889 by Mr. Ehrhardt, and v, with their supplemental works, employ more than 6,000 ands.

The Ehrhardt process, patented by the inventor in 1891, nsists essentially in simultaneously punching and shaping tal blocks. To produce a hollow cylinder, a square piece of d-hot steel (a, Figs. 1 and 2) is placed in a matrix (b). The oss-section of the steel block, measured diagonally, corre- onds to the diameter of the matrix. The latter is then closed the lid d, serving as a guide for a mandrel (c), which is iven into the metal by means of a powerful hydraulic press. The diameter of the mandrel is chosen so that the material orced aside by it is exactly sufficient to fill the four segment-haped spaces (e) between the square sides of the block and he interior surface of the matrix. Thus it is possible to work pon the minimum amount of metal necessary for the produc- on of the piece under consideration.

If R be the radius of the matrix, the radius (r) of the man- rel is found by the formula:

$$\pi r^2 = \pi R^2 - 2R^2$$
$$r = 0.603R.$$

As the metal while being acted upon can give way at the ides, the mandrel enters the metal without great difficulty, d a hollow cylinder with closed bottom, as shown in Fig. 3, produced; the bottom has naturally the shape of the head the mandrel (c). This hollow body can be drawn out anew order to produce tubes with thin walls. In the same way ollow bodies with square sections may be manufactured, hich are punched in a corresponding matrix, the blocks con- ituting the inscribed circle of the rectangular section of the quare to be produced. Blocks of irregular sections may be nched and shaped in quite the same way, there being, how- ver, the necessary condition that the piece of metal be cen- red by the matrix, and that sufficient space be left for re- iving the material pressed away by the mandrel. In press- ng, such an amount of friction is produced against the walls the matrix that the pressure of the mandrel on the block is oportionately small, and only a slight longitudinal com- ession of the material is effected.

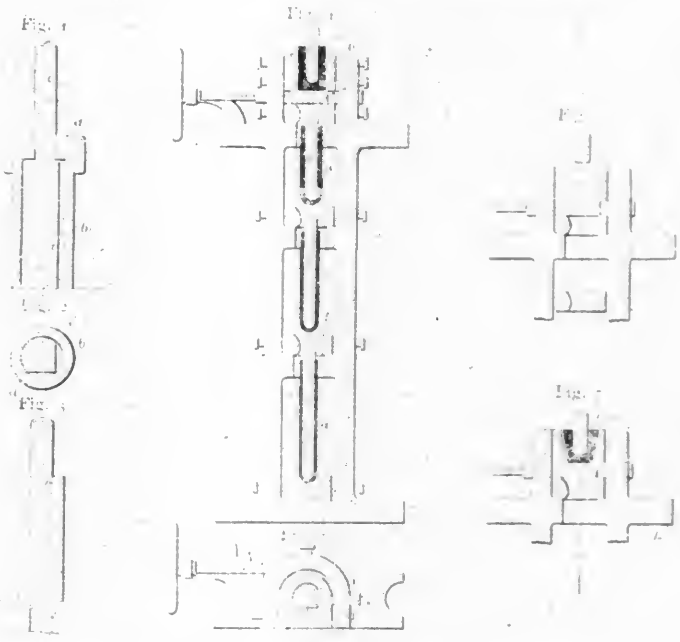
Figs. 4 to 7 illustrate apparatus for producing hollow tubular dies, starting from a blank (a) of any shape. This blank is t punched by means of a mandrel (c) in a die (b) the bot- m of which is formed by a slide (s) which is moved hori- ntally in the die by a screw-spindle and hand-wheel. After metal blank in the die has been perforated as described, slide s is withdrawn, the mandrel is moved downward gether with the tubular body and presses together with the tter successively through the drawing rings d, d₁, d₂, until e tubular body has acquired the requisite thickness. The nching may also be effected by means of a short steel cylin- r and a matrix of a special shape, wider at the top than at bottom (Figs. 6 and 7).

The precision with which objects of determined dimensions produced, and also the smoothness and polish of their sur- es, are remarkable. It is, for example, possible to make e-chamber shrapnels with walls only 2 mm. (0.0787 in.) ck, without the necessity of any machining inside.

In order to produce long weldless hollow bodies—tubes, for stance—the blank, after being perforated, is gripped by the cers of a draw-bench and drawn out, during which opera- n the direction of movement remains the same. Thick tubes n thus be drawn out three times successively without it ing necessary to heat the body after each operation. It is refore possible with one heating only to produce a tube of eat length.

When the thickness of the walls does not exceed 3.5 mm. (0.138 in.) the tubes are generally calibered by cold drawing on a solid bar. A red-hot temperature is very suitable for all these operations, and need not be exceeded. The perfection of the machinery at present employed allows the producing of weldless tubes with a precision of diameter or thickness of 0.1 mm. (0.0039 sq. in.). The mandrel being exactly centered and precisely guided, continues to advance without deviating when the movement has once been correctly started. The manufac- ture of steel flasks for highly compressed gases particularly serves to illustrate the valuable qualities of press work. These flasks, which are made in all sizes, are tested before being officially accepted, by a pressure test made as follows. The flask is filled with water and carefully weighed, then sub- jected to a pressure of at least 250 atmospheres. A steel band laid around the flask serves to determine the expansion result- ing from this test. If it indicates no permanent deformation, the flask is accepted.

In consequence of the pressure operation the strength of



APPARATUS FOR FORMING HOLLOW TUBULAR BODIES FROM THE SOLID BLOCK.

the metal is materially increased; the walls of the flask show an equal solidity and a great tenacity in all parts, so that it can stand a pressure above 500 atmospheres. At a still higher pressure the flask does not break up into fragments, but only splits open at one place. The metal employed must possess a tensile strength 32 to 100 kg. per sq. millimeter, and an elonga- tion of 15 to 30 per cent. After the operation it is found that not only the tensile strength, but also the elongation, has ma- terially increased.

Practical experience has clearly proved the superiority of the Ehrhardt weldless tubes over the best welded tubes for water- tube boilers with thin tubes. For this several reasons are given: First, the metal employed is carefully chosen from among the best products of the Martin furnace, for in order to be able to stand this pressure operation it must be exempt from all defects resulting from casting; furthermore, the cherry-red heat at which the work is performed makes anneal- ing superfluous and thus avoids its detrimental consequences. As there is no weld seam, the inner surface of the object shows no unevenness. The expansions and contractions which occur in the fireboxes of boilers take place in a regular manner, while a weld-seam, though as perfect as possible, breaks the homogeneousness of the metal and constitutes the primary cause for dislocations under the influence of varying tempera- tures. To this cause of inferiority must be added the difficulty experienced in obtaining an irreproachable seam. Lastly, the quality of the material employed for the seamless tubes allows of their being thickened up by upsetting, enlarged by bell- mouthing, or fitted with collars, etc., under the press, which

work cannot be executed with the same degree of perfection on welded tubes. Furthermore, there is no great difference to-day between the prices of production of the two kinds of tubes. The manufacture of welded tubes can only be termed economical in cases where the quality of the metal is of secondary importance owing to the low pressures it has to withstand, as, for instance, in gas and water pipes. The exigencies created by the progress of modern industry are, moreover, only to be satisfied by weldless tubes. Besides, the employment of first-class metal leads to a diminution of the thickness of the walls, and consequently also to economy. These weldless tubes are especially suitable for marine and locomotive boilers; the German Admiralty Office is using them exclusively. The manufacturing of shells has been improved; projectiles of extraordinary tenacity and solidity are thus produced, for which the hardest steel, with a tensile strength of 100 kg. per square millimeter and more, is employed.

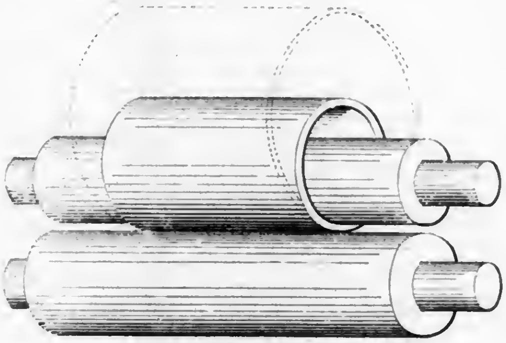


Fig. 8

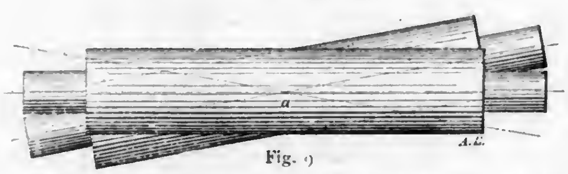


Fig. 9

ARRANGEMENT OF SWIVELING ROLLS FOR ROLLING OUT HEAVY TUBES INTO BOILER BARRELS.

Gun tubes, made from special alloys of steel, are first forged under a forging press and then punched by the Ehrhardt process, thus obtaining a high degree of resistance to pressure in the bore. By building up a gun from a tube and a jacket, both parts being manufactured by the Ehrhardt process and united by shrinkage, its strength is augmented still more. In consequence of the compression undergone by the inner layers of the tube while the bore is being pressed, the surface of the latter becomes very hard and compact, thus obviating to a great extent the erosion which the high temperatures accompanying the combustion of modern powders are liable to produce. In short, the products obtained by the Ehrhardt process are generally recognized to be of most excellent quality.

After having explained fully the Ehrhardt process in making seamless tube from a full square block, I will now explain this process as applied to the rolling out of a heavy tube, made in this manner, into a boiler-barrel.

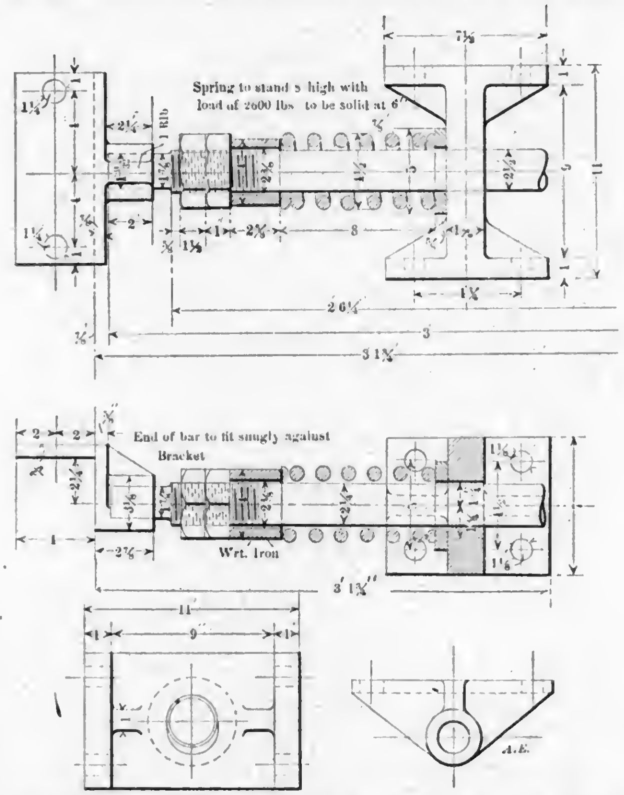
Mr. Ehrhardt uses a rolling mill with two rollers, of which the top roller takes the hollow block and the bottom one swivels in rolling. The hollow block is made of such a diameter that it goes easily over the top roller; the bottom of the blank is cut off so that a cylinder of the finished length remains. The rolling-out to the proper thickness and diameter is done on the rolling mill, which has a very powerful engine. The bottom roller is arranged to swivel right and left (Fig. 9) around the center-point a, and is pressed upward by hydraulic pressure, so that the same pressure is always acting. For facilitating the rolling out and reducing the pressure upon the rollers, the bottom roller oscillates during its work as shown in Fig. 9. In the inclined position the pressure is exerted only in the middle at a, and spreads gradually from the middle position until it covers the whole length of the rollers; as rollers always bend somewhat, this oscillating movement ensures uniform thickness of the cylinder. It is not thicker in the middle, as is usual with rolled plates. For guiding the rolled cylinder side rollers are used, which give a steady run to the cylinder. These side rollers are arranged so that they are fixed by a lever corresponding to the diameter of the boiler-barrel to be produced.

A boiler-barrel made in this way possesses in all its parts an equal resistance, and is far superior to a welded or riveted barrel. The press and rolling mill of Mr. Ehrhardt at Düsseldorf-Reisholz produces boiler-barrels for locomotives and marine from 1 to 5 meters (3.28 to 16.4 ft.) diameter, cylinders for hydraulic presses and accumulators, and all other kinds of hollow bodies of great resistance for great pressures. Locomotive and marine boilers made with seamless barrels, according to Ehrhardt's process, are lighter and of greater resistance, durability and tightness than those made according to the usual method, with welds and rivets.

SPRING CENTERING DEVICE FOR LOCOMOTIVE TRUCKS.

New York Central & Hudson River Railroad.

In order to secure correct conditions of wear of driving wheel tires and to provide for the proper influence of the leading truck in guiding the engine, it is important to employ effective centering devices for the truck. On page 134 of the May, 1900, number of this journal was printed a discussion of



LATERAL SPRING CENTERING DEVICE FOR LOCOMOTIVE TRUCKS.

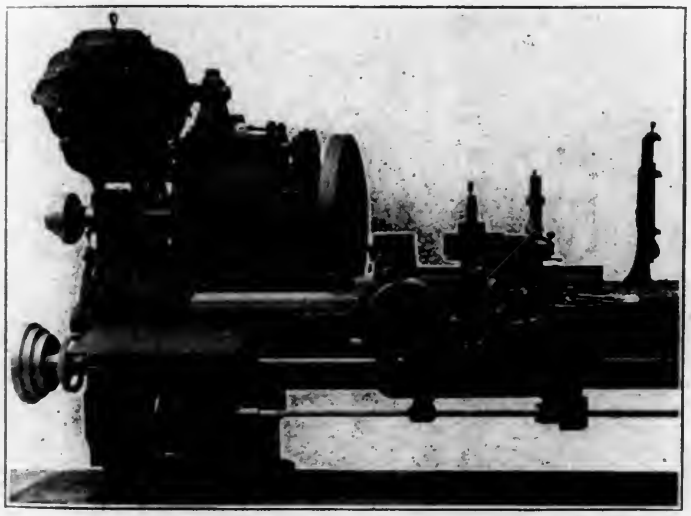
truck link hangers and their influence on the wear of tire flanges. There has been of late a marked tendency toward the use of 3-point truck hangers, employing the weight of the front end of the engine to center the truck. The accompanying engraving illustrates a lateral spring arrangement to serve this purpose. This is similar in principle to the devices which have been used for years in foreign practice and has been applied to the "Central Atlantic" or 4-4-2 type locomotives of the New York Central, which were illustrated on page 36 of the February, 1901, number of this journal. It is believed to be more satisfactory than the 3-point hanger and the construction is such as to permit of adjusting the resistance to side motion through the springs. The drawing is sufficiently clear to explain itself.

MOTOR DRIVEN MACHINE TOOLS.

REPRESENTATIVE EXAMPLES OF INDIVIDUALLY-DRIVEN LATHES.

Supplementary to our article in the previous issue (pages 137-9) descriptive of typical methods of applying electric motors to engine lathes for individual driving, we present herewith further examples of motor applications to lathes. All of the drives shown are those using direct-current motors, the majority being of the variable speed type; fewer examples of the induction (alternating current) motor are to be found as applied to machine tool driving, although the induction motor is meeting with marked success for this work and is fast coming into favor.

The writer is pleased to state that the machine tool builders are taking an exceptional interest in the subject of motor driving, and are for the most part conducting extensive experiments along this line. Important improvements in the method of mounting the motor, as well as in the arrangement of the drive, are to be found upon the advocated method of motor driving for every machine tool of prominence. The variable speed motor is held highly in favor by a great many, but the consensus of opinion seems to be tending toward the use of two or more runs of gearing in the drive to obtain a portion of the speed changes if a variable speed motor is used, or for all of the variations when using a constant-speed motor.

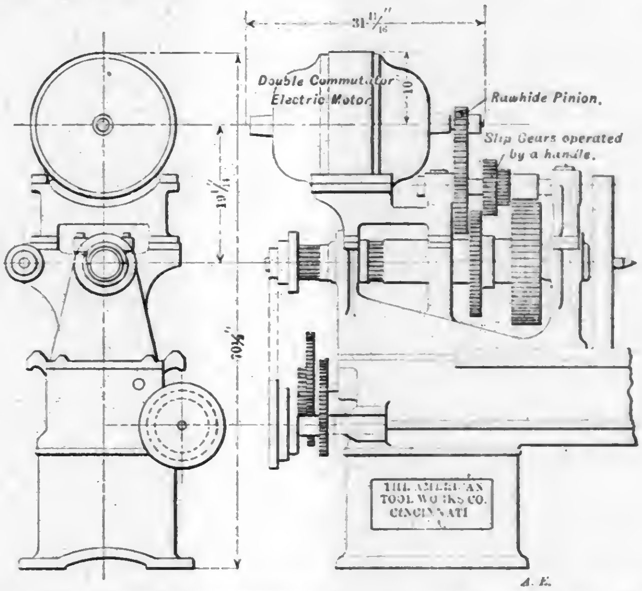


GEARED DRIVE FOR A 24-INCH LATHE.—AMERICAN TOOL WORKS CO. DOUBLE COMMUTATOR VARIABLE-SPEED MOTOR MADE BY THE COMMERCIAL ELECTRIC COMPANY.

The above illustration and drawing represent the interesting type of drive recently applied to their lathes by the American Tool Works Company, Cincinnati, O. The lathe here shown is their standard 24-in. lathe, which is well known for its many commendable features.

It is driven by a 3 h. p. motor of the double commutator type, made by the Commercial Electric Company, Indianapolis, Ind. The motor is mounted on a saddle on the headstock, with communication direct to the spindle by a rawhide pinion and intermediate slip gear. The controlling apparatus for starting, stopping and reversing is simply and conveniently arranged at the right end of the carriage, in the handle shown which operates through a splined controller rod beneath the bed. There are four fundamental speeds obtainable from the motor itself, through the speed controller directly under the head, which operates upon the two wire system in conjunction with the double commutator feature of the motor. This, with the four speed changes in the spindle gearing, gives a total of sixteen distinct and positive spindle speeds available.

The drawing presents the details of the headstock gearing arrangement. The motor drives through the pinion to an intermediate shaft which carries two slip gears, splined so as to permit of being thrown over into mesh with either run of gearing. The movement of these slip gears is controlled by the handle shown above the gear case in the view. These two runs of gears, in addition to the regular back gear attachment, provides the four changes of speed available from the headstock gearing.



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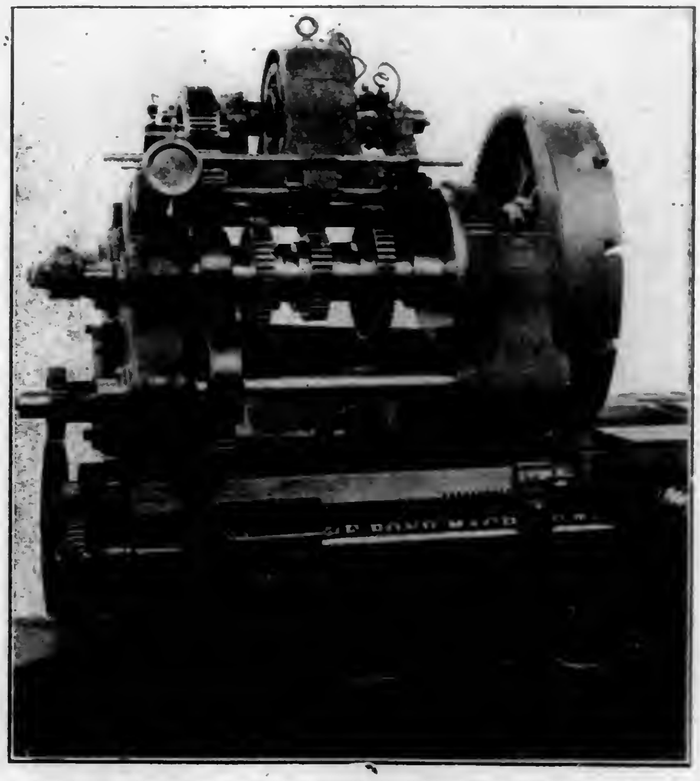
Below is illustrated an interesting motor drive which has been applied to a 54-in. engine lathe made by the Pond Machine Tool Company. The motor is a 7½ h. p. Westinghouse motor, having a speed range from 650 to 930 rev. per min. by field control. It is mounted upon a saddle spanning the headstock frame, from which position it drives an intermediate shaft in front. Upon this intermediate shaft is arranged a slip-gear combination consisting of three pinions in one piece, splined so as to slide along the shaft. Their position is controlled by the hand wheel shown at the left—by it they may be thrown over so as to mesh with any one of the three larger gears upon the driving shaft below. The three gear speeds thus obtain-



GEARED DRIVE UPON A 54-INCH LATHE.—POND MACHINE TOOL CO. VARIABLE-SPEED MOTOR (FIELD CONTROL).—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.

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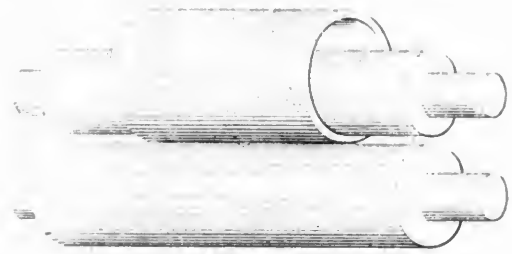

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NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

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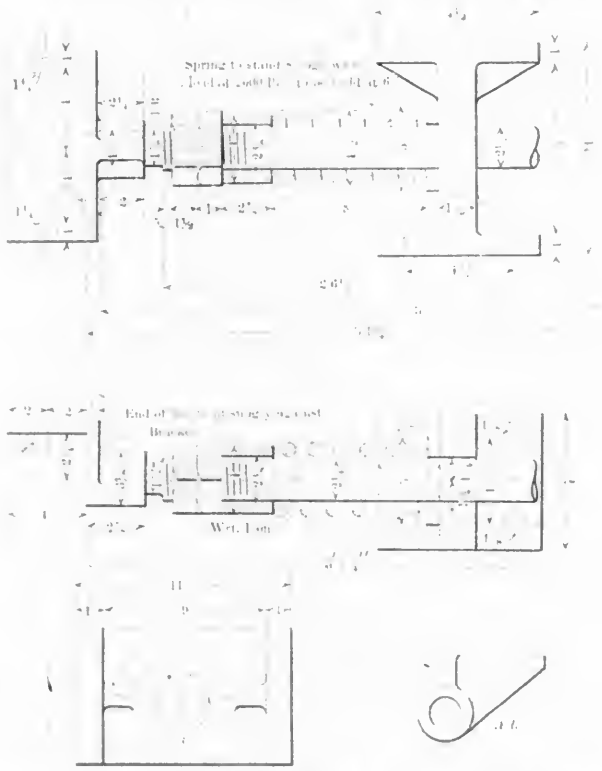

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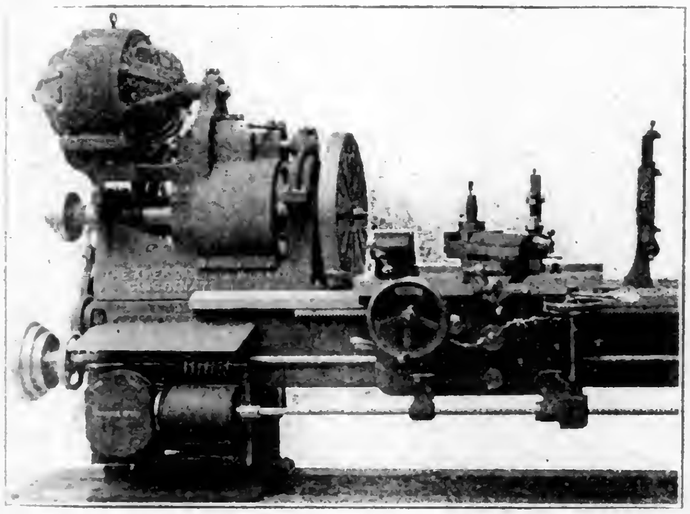

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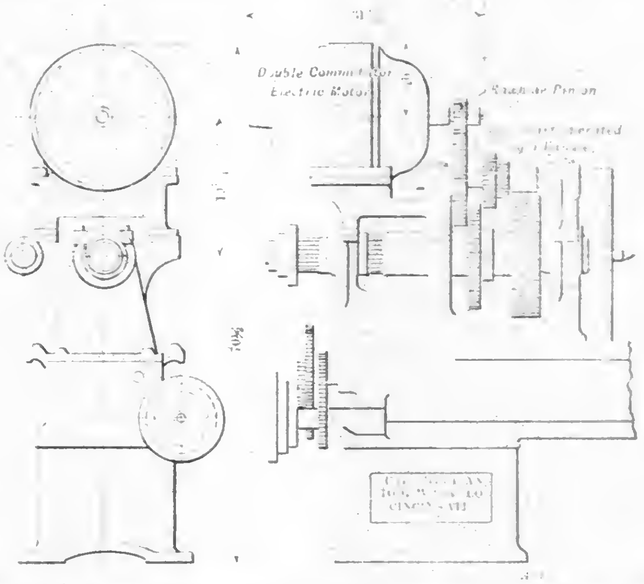

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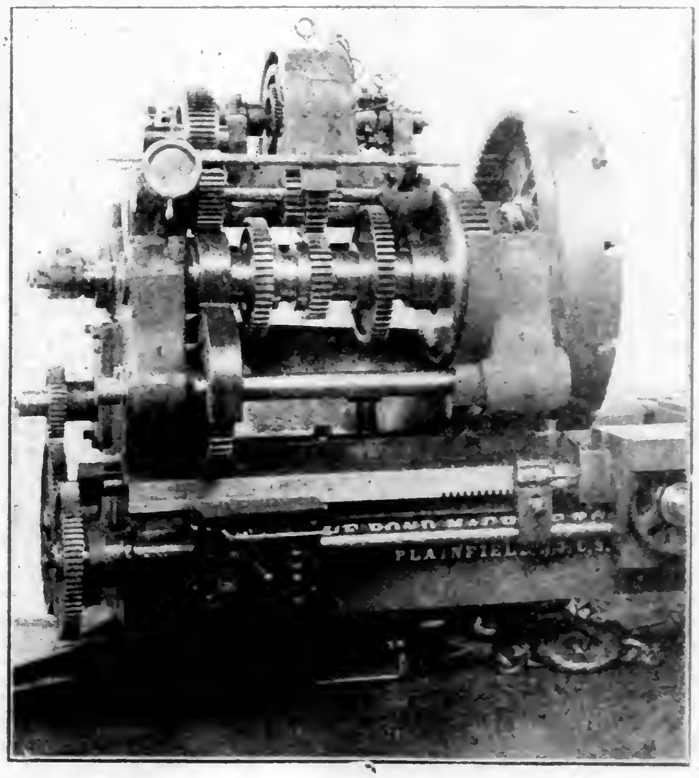
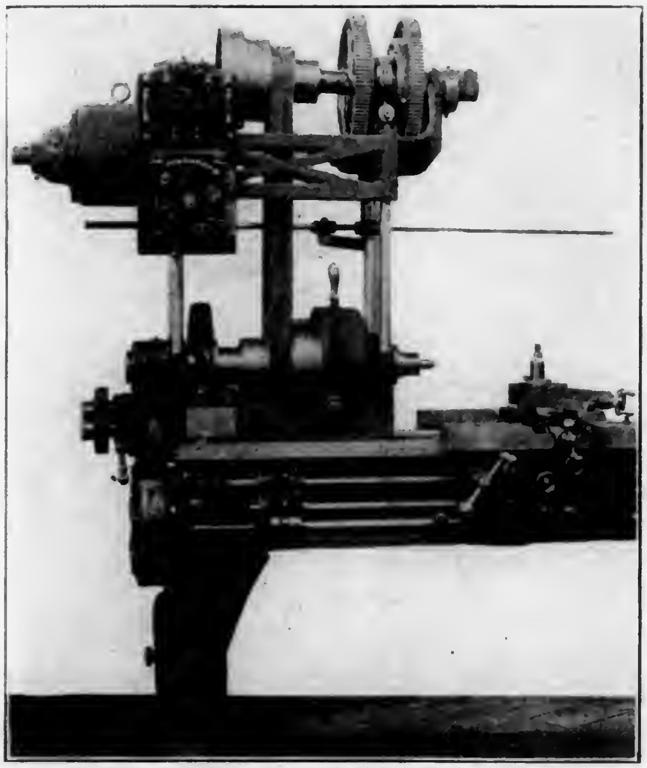


GEARED DRIVE UPON A 54-INCH LATHE.—POND MACHINE TOOL CO. VARIABLE-SPEED MOTOR (FIELD CONTROL).—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.



CONSTANT-SPEED BELTED DRIVE UPON AN "IDEAL" LATHE.—SPRINGFIELD MACHINE TOOL COMPANY.

able are supplemented by the usual back-gear attachment, making thus six spindle speeds available for every motor speed.

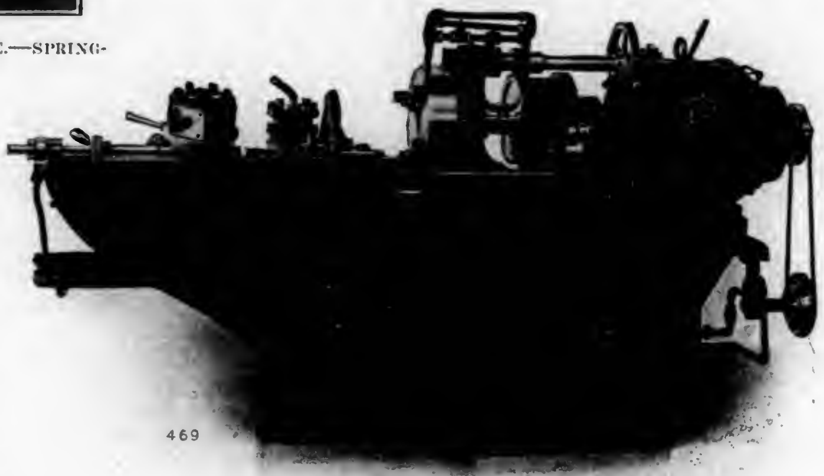
The lathe illustrated in the engraving above is the motor-drive adaptation of the Ideal lathe, a number of which have been furnished to the United States Navy Department by the Springfield Machine Tool Company, Springfield, Ohio. This is the belted or flexible connection type of drive for use with constant-speed motors, which this company has advocated, and it has proven very satisfactory. The motor is not reversible, reversals being accomplished, as well as starting and stopping, by the clutches on the countershaft upon the standard. This arrangement, of course, necessitates a tight belt on account of the close centers of pulleys. The motor shown upon this lathe is a Storey direct-current constant-speed motor.

This company has recently developed an improved arrangement of geared drive, which marks an important advance in motor driving applications. They are making unusual progress in this important branch of work.

The lower engraving illustrates a motor drive application to a Jones & Lamson flat turret lathe. The motor, which is a type N direct-current motor made by the Bullock Electric Manufacturing Company, Cincinnati, O., is conveniently located upon a cast-iron bracket at the rear of the headstock. The motor drives direct through an intermediate pinion to the large spindle gear. A valuable feature of this application is the fact that all the gears are encased in a sheet metal casing, keeping out dirt and preventing injury to the gears, or to workmen.

The motor is operated upon the multiple-voltage system for variable speeds, the controller for which is shown located at the end of the bed at the left; the handle projects out on the front side of the lathe. This controller gives 26 speeds in forward motion and six in reversal.

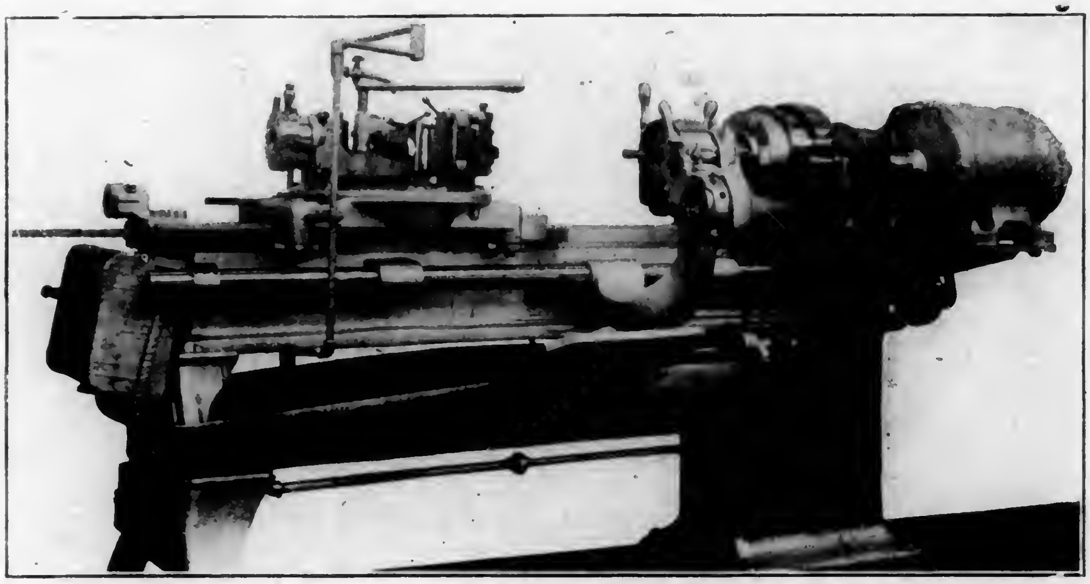
Another application of the multiple-voltage motor drive is presented in the engraving below. This illustrates a 13-in. Gisholt turret lathe gear driven direct from a type N variable-speed motor made by the Bullock Electric Manufacturing Company. The drive is in this case also from the motor pinion through an intermediate gear direct to the spindle. The 26 speeds furnished by the controller are here assisted by the use of the usual back gear upon the lathe.



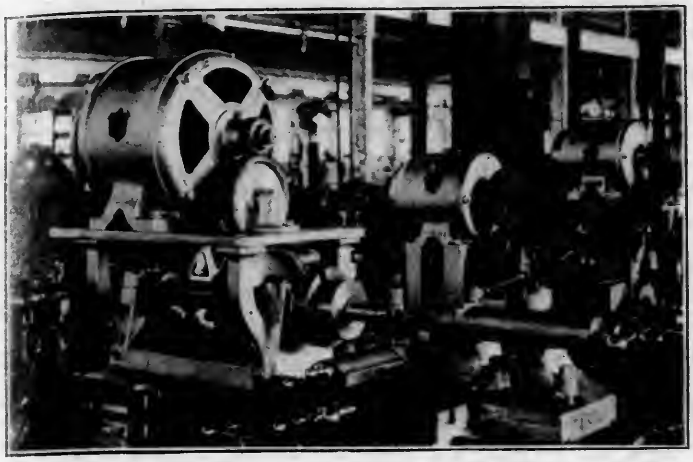
GEARED DRIVE UPON A TURRET LATHE.—GISHOLT MACHINE COMPANY. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

The motor is supported by a convenient cast-iron bracket at the rear of the head.

Some interesting lathe drives are shown in the upper engraving on page 195, which represents a view in the tool room at the Bullock Electric Manufacturing Company's works. The drives shown are cases where multiple-voltage motors have been mounted upon standards above the lathe headstocks and drive direct to the spindles by gearing. In all these cases the motor's variable speeds are supplemented by the lathe back-



DIRECT GEARED DRIVE UPON A JONES & LAMSON FLAT TURRET LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRICAL MANUFACTURING COMPANY.



GEARED DRIVES UPON TOOL ROOM LATHES AT WORKS OF BULLOCK ELECTRIC MANUFACTURING COMPANY.

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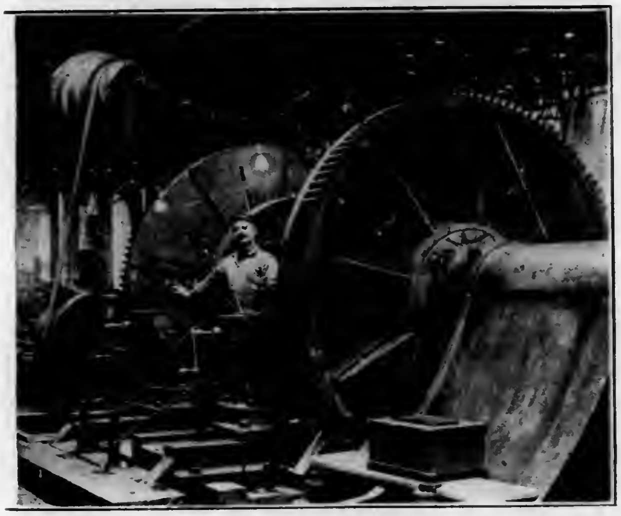

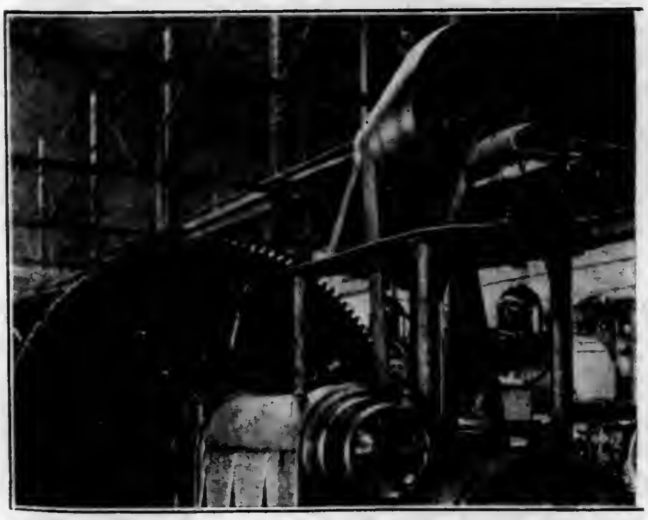

CONSTANT-SPEED MOTOR DRIVE UPON A LARGE BEMENT-MILES WHEEL LATHE.—AN ADAPTATION TO AN OLD TOOL.

LOCOMOTIVE TESTS ON THE PRUSSIAN STATE RAILWAYS.

SUPERHEATER AND COMPOUND LOCOMOTIVES.

(TRANSLATED EXTRACTS FROM REPORT BY HERRN PROF. VON BORRIES.)*

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Type.	Numbers.	Weight in Working Order, Pounds.	Grate Area, Sq. Ft.	Heating Surface, Sq. Ft.	Boiler Pressure, Lbs. Sq. Ins.
Four-cylinder compound.	17, 18	116,500	24.7	1,278	200
Super-heater	439, 440	120,350	24.7	1,134	170
Two-cylinder compound.	42	104,900	24.7	1,345	170

In calculating the average figures which are tabulated below, all those which were not properly comparable by reason of unfavorable weather conditions have been discarded, the number of trips considered being as shown in the first line of the table. In calculating the hourly fuel and water consumption per square foot of grate area and heating surface (lines 22 and 23), a deduction of five minutes has been made from the total running time (line 2) to give actual time at speed, exclusive of slow-down on passing through Lehrte station and at the ends of the run. This deduction was, however, not made in calculating the horse-power developed per pound of coal (lines 18 and 19), in order to make allowance for the work done in accelerating the train, which is not otherwise accounted for.

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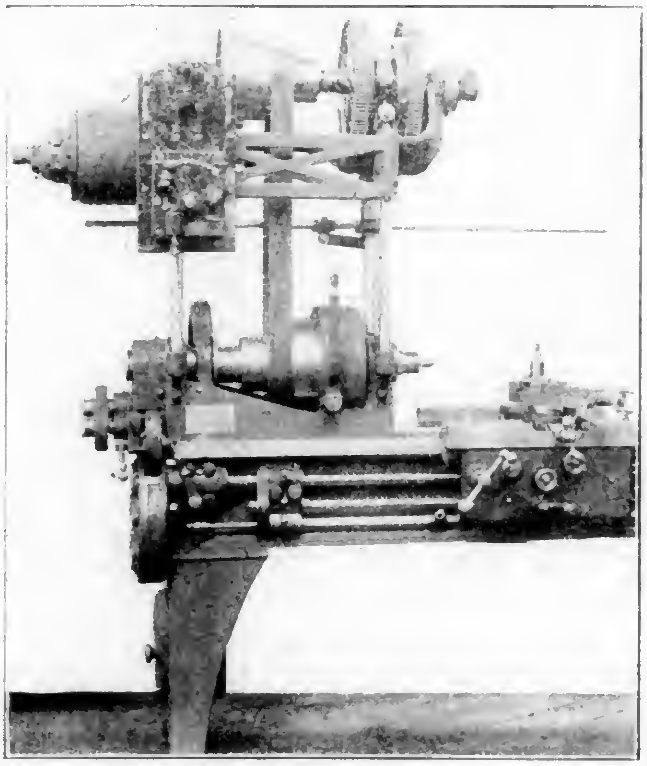
A comparison of the smoke-box draught (line 5) shows that the same rate of combustion was attained with a much lower vacuum for the superheater engines. The same thing was shown by a measurement of the temperature of combustion. In making this measurement the vacuum in the rear upper corner of the fire-box was measured and found to average for the four-cylinder compound about 54 per cent., and for the superheater about 45 per cent. of the vacuum in the smoke-box, the difference being doubtless due to the greater area of the flues in the superheater locomotive. The total horse-power (line 13) is about 5 per cent. higher for the superheater than for the four-cylinder compound, chiefly on account of the 9 per cent. greater evaporation (line 22). The effective horse-power developed per pound of coal per hour is, on the other hand, about 7 per cent. better for the four-cylinder compound. In comparison with the earlier superheater engines tested in 1901, the power of the new engines (lines 13, 14, 18, 19 and 20) is higher by about 12 per cent. on the average. This is in accordance with the expectation expressed (by Herrn von Borries) in reporting the tests made on the previous engines.

In regular express service on the Stendal division between June 1 and August 15 the coal consumption per train-mile

*Zeitschrift des Vereins Deutscher Ingenieure of Nov. 22, 1902.



CONSTANT-SPEED BELTED DRIVE UPON AN "IDEAL" LATHE.—SPRINGFIELD MACHINE TOOL COMPANY.

able are supplemented by the usual back-gear attachment, making thus six spindle speeds available for every motor speed.

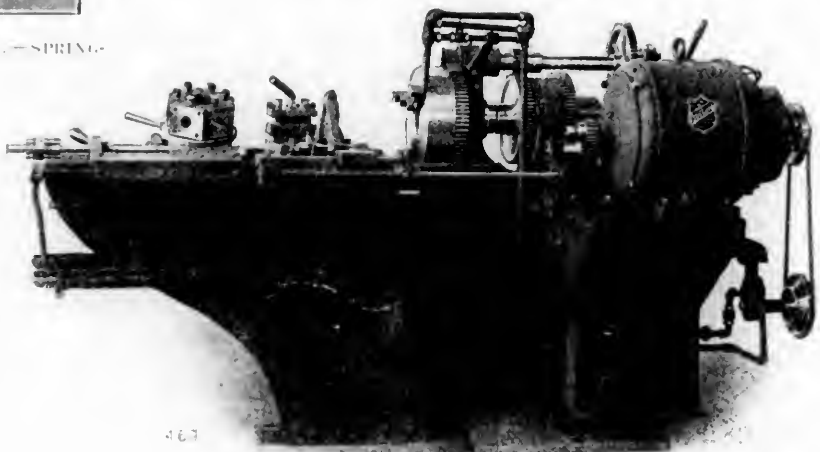
The lathe illustrated in the engraving above is the motor-drive adaptation of the Ideal lathe, a number of which have been furnished to the United States Navy Department by the Springfield Machine Tool Company, Springfield, Ohio. This is the belted or flexible connection type of drive for use with constant-speed motors, which this company has advocated, and it has proven very satisfactory. The motor is not reversible, reversals being accomplished, as well as starting and stopping, by the clutches on the countershaft upon the standard. This arrangement, of course, necessitates a tight belt on account of the close centers of pulleys. The motor shown upon this lathe is a Storey direct-current constant-speed motor.

This company has recently developed an improved arrang ment of geared drive, which marks an important advance i motor driving applications. They are making unusual progre in this important branch of work.

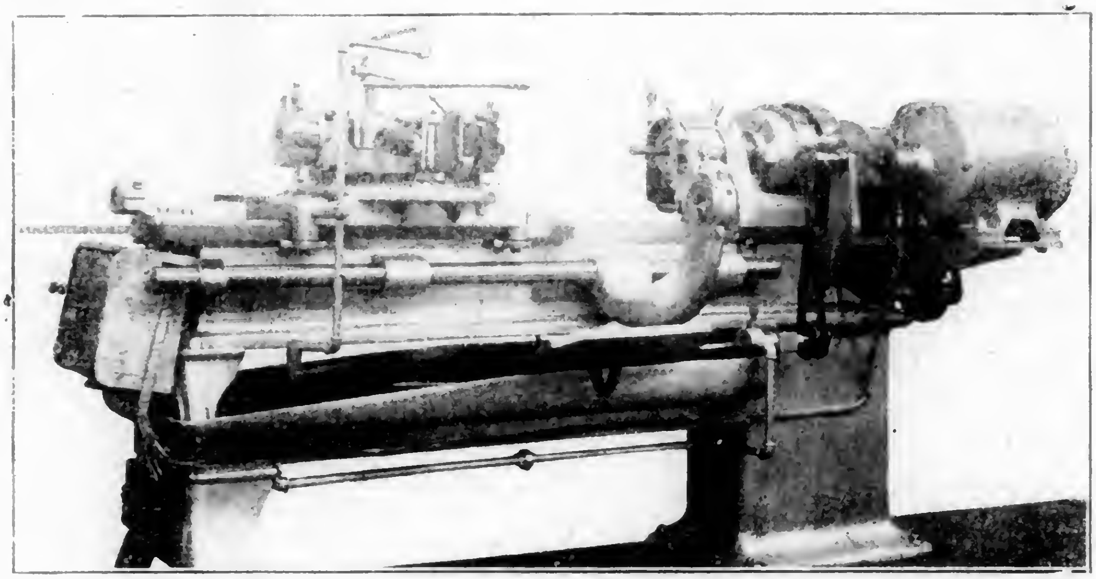
The lower engraving illustrates a motor drive application u a Jones & Lamson flat turret lathe. The motor, which is type N direct-current motor made by the Bullock Electri Manufacturing Company, Cincinnati, O., is conveniently lo cated upon a cast-iron bracket at the rear of the headstock The motor drives direct through an intermediate pinion to the large spindle gear. A valuable feature of this application i the fact that all the gears are encased in a sheet metal casing keeping out dirt and preventing injury to the gears, or to workmen.

The motor is operated upon the multiple-voltage system for variable speeds, the controller for which is shown located at the end of the bed at the left; the handle projects out on the front side of the lathe. This controller gives 26 speeds in forward motion and six in reversal.

Another application of the multiple-voltage motor drive is presented in the engraving below. This illustrates a 13 in. Gisholt turret lathe gear driven direct from a type N variable-speed motor made by the Bullock Electric Manufac turing Company. The drive is in this case also from the motor pinion through an intermediate gear direct to the spindle. The 26 speeds furnished by the controller are here assisted by the use of the usual back gear upon the lathe



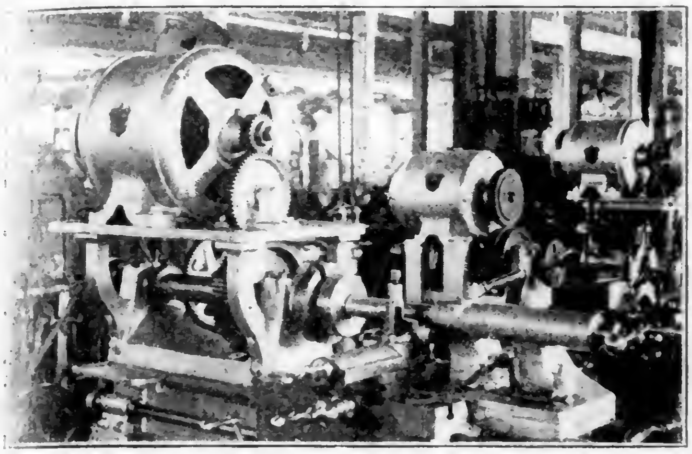
GEARED DRIVE UPON A TURRET LATHE.—GISHOLT MACHINE COMPANY. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC MANUFACTURING COMPANY.



DIRECT GEARED DRIVE UPON A JONES & LAMSON FLAT TURRET LATHE. MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRICAL MANUFACTURING COMPANY.

The motor is supported by a convenient cast-iron bracket at the rear of the head.

Some interesting lathe drives are shown in the upper engraving on page 195, which represents a view in the tool room at the Bullock Electric Manufacturing Company's works. The drives shown are cases where multiple-voltage motors have been mounted upon standards above the lathe headstocks and drive direct to the spindles by gearing. In all these cases the motor's variable speeds are supplemented by the lathe back-



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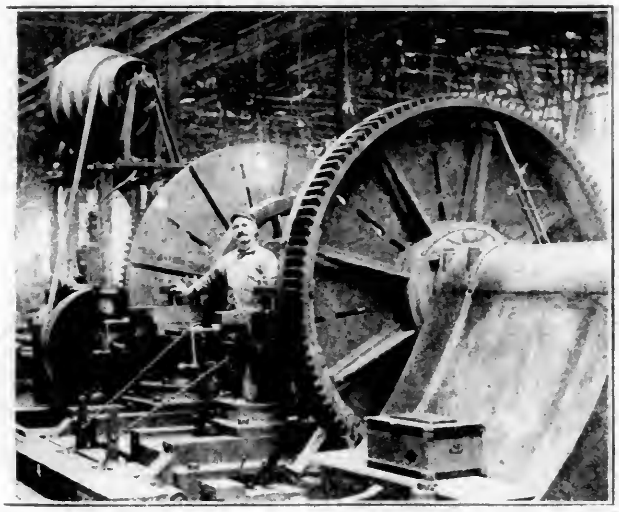

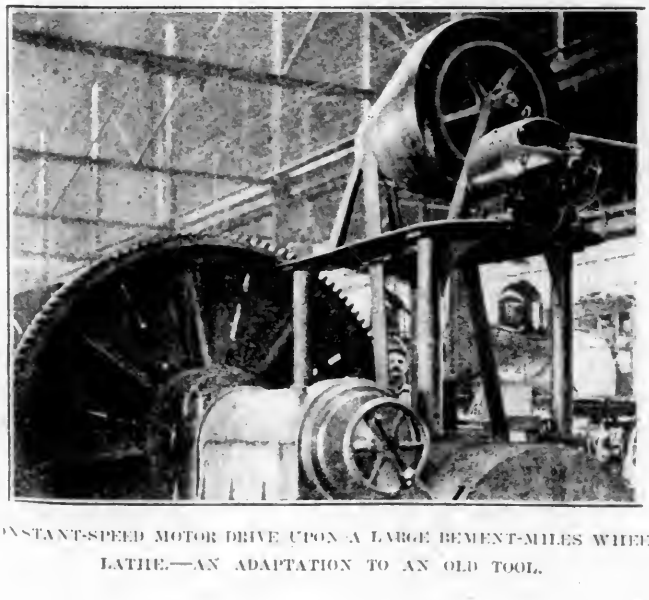

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LOCOMOTIVE TESTS ON THE PRUSSIAN STATE RAILWAYS.

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amounted on the average to the figures given below, and the individual figures did not show any great variation:

3 Four-cylinder compounds	39.41 pounds
2 Superheaters	40.15 pounds
1 Two-cylinder compound	39.80 pounds

On the Halle division the following figures were obtained:

Type of Engine.	Average Consumption per Engine Mile. Coal.	Water.
Four-cylinder compound	38.89 lbs.	270.7 lbs.
Superheater	37.89 lbs.	226.9 lbs.

The power of both types was practically the same.

Taking all of the tests of express engines together, the results lead to the following conclusions: The four-cylinder compounds run very quietly and evenly, with absolutely no pound in the machinery, and this easy riding has a very favorable effect on the comfort of the crews, who for this reason prefer these engines to any others. The cost of maintenance of track and engines should also be favorably influenced. The power developed by these four-cylinder compounds was cut down considerably by the dampness of the steam, and it would be advantageous, in order to secure greater economy with future engines, to arrange to use steam superheated to about 482 deg. Fahr. This would give a desirable increase of power and a reduction of the fuel and water consumption.

The superheater engines showed, as was noticed above, an increase of power (lines 13 and 14) in comparison with the engines tested in 1901. This increase amounted to about 15 per cent. and is mainly due to the increase of the cylinder diameter from 18.11 ins. to 20.47 ins., which enabled the test trips to be made with an average cut-off of 15 per cent. of the stroke instead of 26 per cent., as previously. As this cut-off may be regarded as the most economical, the present cylinders appear to give the best possible steam distribution, so that no further increase of power is to be looked for with these engines while single-expansion cylinders are used. The power developed per pound of fuel (line 18) is somewhat less with the superheaters than with the four-cylinder compounds, and consequently the power developed per pound of total engine weight cannot be greater for a superheater locomotive than for a four-cylinder compound, and therefore in my opinion it will not be practicable to build superheater locomotives of the 4—4—0 type to give the same power as the 4—4—2 and 4—6—0 type four-cylinder compounds, which with from 2,150 to 3,200 sq. ft. of heating surface develop from 1,300 to 1,600 h.p. The increase in cylinder diameter increased the piston stroke, which consequently gave rise to a considerable shaking of the engine, which was very unpleasant for the crew and bad for the maintenance of the machine.

FREIGHT ENGINES.

The eight-wheeled eight-coupled (0—8—0 type) superheater freight engines were thoroughly tested on the Saarbrucken division. Four of these engines and four compound locomotives of the same type were used for hauling heavy ore and coke trains on the Mosel Railroad. The maximum loads for the grades of 1 per cent. were calculated at 100 loaded car axles for the superheater, weighing 121,700 lbs., and 90 axles for the compound, weighing 116,800 lbs. In actual service the trains averaged 107 axles for the superheaters and 100 for the compounds. The coal and water consumption per 1,000 loaded axle-miles averaged:

Type of Engine.	Coal.	Water.
Superheater	605 lbs.	4,092 lbs.
Compound	565 lbs.	4,465 lbs.

These show that the superheaters worked with 8.7 per cent. less water but used 6.3 per cent. more coal. On a neighboring road two superheaters consumed 663 lbs. of coal per 1,000 axle-miles, as did the compounds, so that no saving was shown. If the compound locomotives had been of the same weight and had had piston valves like the superheaters for the high-pressure cylinders, the power and coal consumption for full loaded trains would probably have been practically the same.

The results as they stand are somewhat surprising, as it was to be expected that freight service was just where the superheaters would make a particularly good showing, owing to their better adaptation to the varying tractive power and to their better draught with four exhausts in each revolution. The small amount of economy shown in the water consumption leads one to suspect steam losses which might be due to leakage past the piston valves.

CONCLUSIONS.

From the combined results of all these tests I consider it unwise to abandon the use of compound cylinders with the introduction of superheated steam. On the contrary, I believe that the four-cylinder compound locomotive will be found in every way the most appropriate for the requirements of the future. The two-cylinder single-expansion engine has its best opportunity in freight service, where, on account of the low speed, the high piston pressure is less injurious; and yet even here a test with superheated steam and compound cylinders might be advisable.

TABLE OF RESULTS OF TESTS.

Number.	Item.	Unit.	Four-Cylinder Compound.	Superheat.	Two-Cylinder Compound.
1.	Number of trips		20	22	12
2.	Total running time, Hanover to Stendal, or back	min.	112.3	108.5	114.7
3.	Actual running time in Gross Mohringen block (77.7 miles)	min.	84.7	82.4	85.8
4.	Average speed in the block (V)	miles pr. hr.	54.8	56.4	54.0
5.	Average vacuum in smokebox	inches of water	3.56	3.86	4.24
6.	Average cut-off in per cent. of stroke	per cent.	34	15	45
7.	Average temperature of steam	degrees F.	....	527	....
8.	Average weight of locomotive and tender (L)	Tons (2000 lbs.)	95.75	98.10	83.45
9.	Average weight of train (W)	Tons	315.0	302.1	283.8
10.	Average tractive power for engine and tender $T_1 = L\left(7.6 + 4.6\,V\,\frac{V+20}{1,000}\right)$	lbs.	2515	2685	2165
11.	Average tractive power for train $\left(T_2 = W\,3.2 + 1.55\,V\,\frac{V+31}{1,000}\right)$	lbs.	3310	3275	2920
12.	Average total tractive power $(T_1 + T_2)$	lbs.	5825	5960	5085
13.	Average horse-power $\left(\frac{T_1+T_2}{375}V\right)$	H. P.	851	897	732
14.	Average useful horse-power $\left(\frac{T_2}{375}V\right)$	H. P.	484	492	420
15.	Water used in single trip	lbs.	25600	22900	25100
16.	Coal used on round trip	lbs.	6660	7030	6470
17.	Water evaporated per pound of coal	lbs.	7.68	6.54	7.77
18.	Horse-power developed per pound of coal per hour $\left(2\frac{\text{No. 2}}{60}\cdot\frac{\text{No. 13}}{\text{No. 16}}\right)$	H. P.	0.48	0.46	0.43
19.	Useful horse-power developed per pound of coal per hour $\left(2\frac{\text{No. 2}}{60}\cdot\frac{\text{No. 14}}{\text{No. 16}}\right)$	H. P.	0.27	0.25	0.24
20.	Useful horse-power developed per ton of locomotive, exclusive of tender $\left(\frac{\text{No. 14}}{\text{weight}}\right)$	H. P.	8.30	8.16	8.00
21.	Actual effective running time (No. 1, less 5 minutes)	min.	107.3	103.5	109.7
22.	Water evaporated per square foot of heating surface per hour $\left(\frac{\text{No. 15}}{\text{heating surface}}\cdot\frac{60}{\text{No. 21}}\right)$	lbs.	13.2	13.8	12.1
23.	Coal burned per square foot of grate per hour $\left(\frac{\text{No. 16}}{2\times\text{grate area}}\cdot\frac{60}{\text{No. 21}}\right)$	lbs.	90.1	98.6	86.6

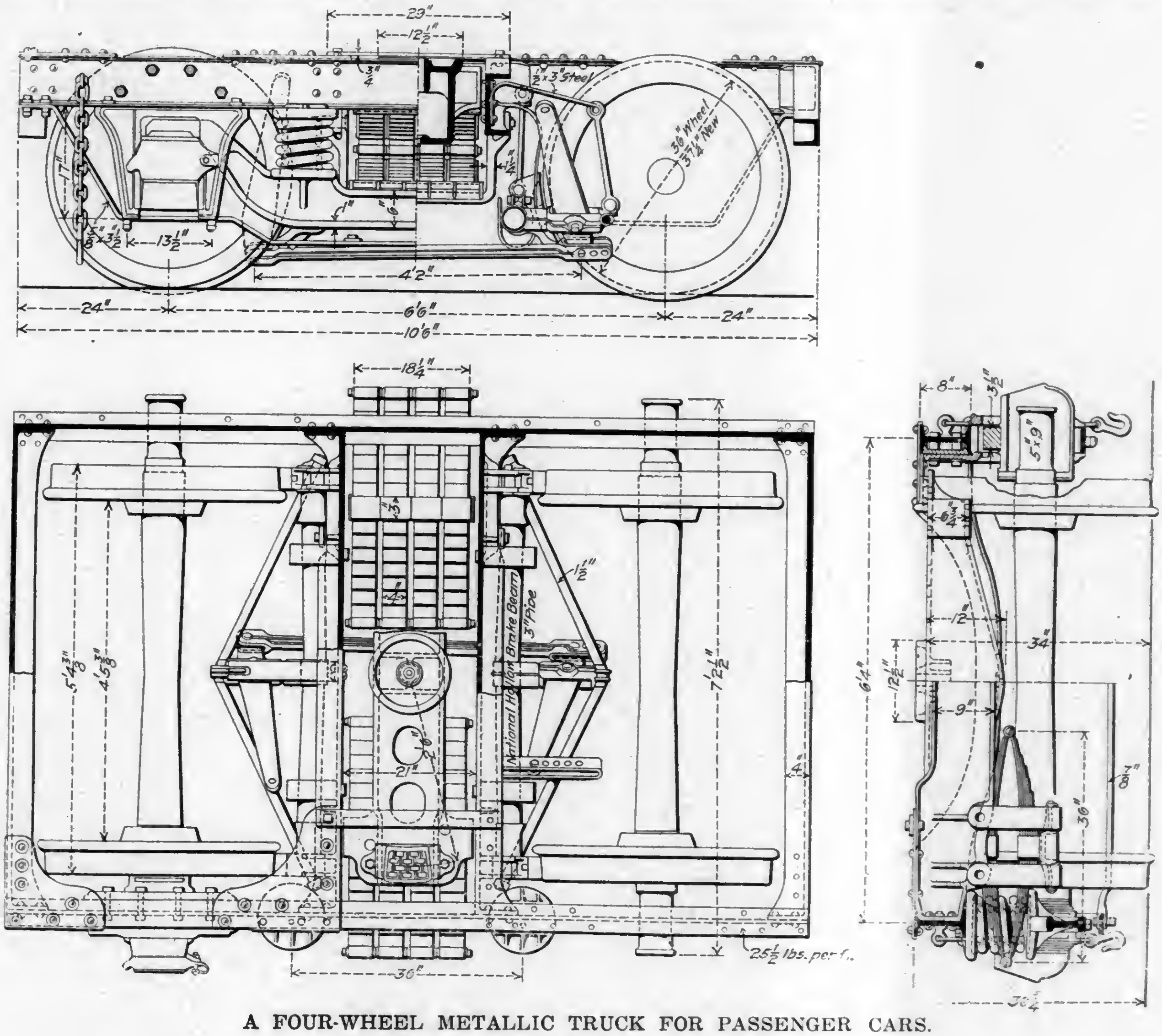
The sudden death of W. W. Card in Pittsburg, April 4, brings a shock to many who have known him for years, and it has brought tributes from all directions to his memory as one of the prime movers in the development of the air-brake. He was in his 72d year, having retired from the Westinghouse Air Brake Company only last year. He entered its service in 1872, became secretary in 1879, and was closely associated with Mr. George Westinghouse in bringing the air brake to its success.

METALLIC TRUCK FOR PASSENGER CARS.

FOUR-WHEEL, WITH 5 BY 9 INCH JOURNALS.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

A number of steel passenger car trucks have been brought out within a few years in an effort to reduce weight and complication. The Lake Shore & Michigan Southern metallic truck (AMERICAN ENGINEER, January, 1901, page 12) has given good results under postal cars, where it has replaced six-wheel trucks, and the riding qualities do not appear to be inferior. If four-wheel trucks can be made to ride well, there is no doubt of their place in passenger equipment practice in the future.



A FOUR-WHEEL METALLIC TRUCK FOR PASSENGER CARS.
ATCHISON, TOPEKA & SANTA FE RAILWAY.

This truck employs the M. C. B. 5 by 9 in. axles. Its side pieces are 8 in. 25½-lb. I-beams with cast steel truck end sills and cast iron transoms. The truck bolsters and equalizers are also of cast steel. The method of spring suspension is clearly indicated in the drawing. Cast steel gusset connections are used to stiffen the attachments of the end sills and transoms. Other details of construction are shown in the engraving. The weight of the truck, complete with brake rigging, is 12,600 lbs. It is equipped with roller side bearings.

These trucks have already been used under ten baggage and five combination baggage cars built for this road by the Pullman Company last year, and they will also be used under ten similar cars now being built. These interesting drawings have been received from Mr. G. R. Henderson, superintendent of motive power of this road.

LOCOMOTIVE TESTS—ATCHISON, TOPEKA & SANTA FE RAILWAY.

NARROW AND WIDE FIREBOXES AND COMPOUNDING.

Now that the wide firebox is a feature of so large a proportion of the locomotives being built, and the merits of compounding still being under such serious discussion, the results of some tests taken under the most favorable conditions for determining the relative advantages of these two features of locomotive design seem worthy of consideration.

The tests under discussion were made on two consolidation engines having identically the same tractive force, viz., 40,000 lbs., one engine having 22 x 28-in. simple cylinders, with piston valves and a narrow firebox, the other engine having tandem-compound cylinders, 16 and 18 x 32 ins. and wide firebox. (See AMERICAN ENGINEER, June, 1902, page 179). Both engines carried 210 lbs. of steam and had 57-in. drivers. Below is a comparative table showing the leading dimensions of the two engines:

COMPARISON OF LOCOMOTIVES.

	Simple.	Tand.-Comp.
Cylinders	22 x 28 ins.	16 & 28 x 32 ins.
Steam pressure	210 lbs.	210 lbs.
Diameter drivers (outside)	57 ins.	57 ins.
Firebox	41¼ x 121 ins.	71¼ x 97 ins.
Tubes—		
Number	411	355
Diameter	2 ins.	2 ins.
Length	13 ft. 6 ins.	15 ft. 0 in.
Wheel Base—		
Rigid	15 ft. 4 ins.	15 ft. 4 ins.
Engine	23 ft. 8 ins.	24 ft. 1 in.
Total	53 ft. 5 ins.	53 ft. 10 ins.
Weights—		
On drivers	180,000 lbs.	174,000 lbs.
Engine	197,000 lbs.	199,200 lbs.
Total, engine and tender	309,900 lbs.	316,700 lbs.

The tests were made on a heavy grade 65.4 miles long, the first 49 miles of 53 ft. to the mile and the last 16.4 miles 74 ft. to the mile. It was a dead pull the whole distance, there being no "let-ups." The conditions were fair in both cases, the engines steaming well, their machinery being in good shape and there being practically no leaking. The object of the tests was to determine the coal consumed per 100-ton miles, and the only data taken beyond the general conditions were the coal burned and the tonnage handled.

The actual coal burned per trip on the simple engine was about 25 per cent. greater than that on the compound, but the difference in the coal burned per 100-ton miles on the two engines, which is the true measure of the work performed, was greater than this, due to the compound engine handling from 150 to 250 more tons per train than the simple engine. The rating for the two engines on the grades mentioned is as follows:

	Simple.	Tand. Comp.
On 53-ft. grade	1,050 tons	1,250 tons
On 74-ft grade	850 tons	1,000 tons

These engines made with this tonnage an average speed while running of nearly 13½ miles per hour.

Below is the coal consumption, being an average of the tests made:

	Simple.	Tand. Comp.
Coal burned per 100-ton miles	30.9 lbs.	21.0 lbs.
Difference in favor of tandem-compound engine, using simple engine as a basis		32.04 per cent.

It would be interesting to know how much of this saving was due to the wide firebox, increasing the efficiency of the boiler, and how much to the compounding. But as such information would be very expensive to secure, involving as it does long series of tests with costly changes in the engine, it would probably be impossible to get a managing official to sanction the expenditure.

We are indebted to Mr. G. R. Henderson, superintendent of motive power, and Mr. R. S. Wickersham, assistant engineer of tests, for this interesting information.

LIQUID FUEL BURNERS.

"There are several good burners in the market and many more which are simply mechanical monstrosities. Some burner enthusiasts are often heard to claim that they could save from 25 to 50 per cent. of the oil used by any other burner. To show the unreasonableness of such claims it is enough to direct attention to the fact that with a properly set stationary boiler 15 to 15½ lbs. of water may be evaporated from and at 212 deg. per pound of oil, containing, say, 14,000 B. T. U. per pound. With the losses due to stack temperature and radiation, 80 per cent. of the theoretical evaporative duty of the fuel is about as good as we can get. Taking the theoretical evaporation of our oil at 19.6 lbs. of water per pound of oil, we have 15.6 lbs. of water evaporated, which is very close to the result stated, the loss being due entirely to stack temperature and to furnace setting. I have seen very few burners which would not atomize well enough to give 13 lbs. evaporation, and with the majority 14 to 15 lbs. is the rule. Now, if the inventor who is going to save 50 per cent. can evaporate even 13 lbs. of water with one-half pound of oil, he has certainly equalled the solution of the problem of perpetual motion."

This paragraph is quoted from a paper entitled "Liquid Fuel" read before the American Society of Naval Engineers by Mr. W. D. Hoffman, associate member of the society. It is the best discussion of the subject we have seen, because it presents information from a wide experience and deals with principles. One of the chief of these is the necessity for such furnace construction as will permit of sufficient length of flame to insure combustion of the oil. The main point in handling oil fuel is the construction of the furnace. Mr. Hoffman gives very valuable information concerning liquid fuel as applied to locomotives, Mr. Hoffman in this paper has established his position as an authority on liquid fuel. It is a matter of regret that space permits of only a brief reference to it here.

MICA METALLIC PACKING.

As steam pressures and the exactions of service of steam engines of all types increase, the matter of good valve-stem and piston-rod packing becomes correspondingly more important. This is particularly true of locomotive service, where mileage in times of stress of business depends largely upon the efficiencies of relatively small details of design and construction.

Mica metallic packing has been developed to meet the requirements of engines, pumps, steam hammers, air compressors; in fact, for every form of rod packing, and espe-

cially upon locomotives. It is reported to be giving good results in all of these services. It is made in the form of rings, and the following advantages are urged in its favor:

It is intended to work equally well with or without lubrication, and this is specially important for packing in inaccessible places. This is a pliable material and fits the rod by virtue of the compression of the gland, and is not dependent upon the actual fitting of the packing because of its form. It is said that the packing need not be removed from the rod when worn so that it blows. The remedy is to add another ring. This packing is stated to be self-adjusting to fit worn or fluted rods, so that it will by the pressure of the gland, be compressed to fit all openings. A packing which becomes hard in service may require chipping for removal. It is claimed that this packing always remains soft, so that it may, if necessary, be blown out. Packing which will fulfill these requirements has strong claims for the attention of railroad officers. The manufacturers are the American Metallic Packing Company, Williamson building, Cleveland, Ohio.

BLUE LEAD AS A PIGMENT FOR PAINTS.

An argument in favor of graphite as a pigment for paint has been received from the manufacturers of a successful paint. It is reproduced as follows:

When pure linseed oil is applied to a wood or metal surface and is allowed to remain a sufficient time, it leaves a tough film over the surface. This film is full of minute pores. That this coating may exclude moisture and corrosive gases from the covered surface these minute pores must be closed. Pigments are put into paint for this purpose. The substance that can most completely close the pores of this oil coating, that is itself the most indestructible and that does not have an injurious effect upon the surface to be protected, makes the best paint, provided its specific gravity be right.

Red lead is very heavy. For this reason it makes a good coat for the top of horizontal surfaces and is really unsuited for all others. The weight of the particles makes the pigment settle through the film of oil and causes the paint to stick closely to top surfaces. Red lead will streak on vertical surfaces and is unsuited for use on under sides. Another very grave difficulty with this pigment is that it is impossible to keep it from settling and hardening in the package after it is mixed without the introduction of material injurious to the quality of the paint produced.

Graphite is a very light pigment and is most admirable for under sides and vertical surfaces, where it makes a closely adherent coating. On upper surfaces it is not equal to red lead, as the pigment rises to the top of the oil film in such cases. Iron oxides, or metallic paints, as they are popularly called, are not to be relied upon unless the chemical composition of the pigment is accurately known. In many cases so-called iron oxide paints accelerate rather than retard the corrosion of steel structures.

The pigment which is believed by these manufacturers to most nearly fill the requirements of a perfect paint is made by a special sublimation process from native high-grade

galena. In color it is a dark steel blue. It is of such a fluffy fineness and it has such an avidity for oil that the paint when dry makes a hard, enamel-like coating. That the pores of the oil film are closed absolutely by this pigment is evident from the long and trying tests this paint has endured without injury. The pigment itself is chemically durable and is proof against any acid or gas encountered in practice. It is neutral toward metal surfaces and is entirely non-corrosive. The specific gravity of this pigment is such that it makes a smooth, uniform mixture and never settles sufficiently to become hard in the package. Its specific gravity lies between that of red lead and graphite and enables it to be used with most satisfying results on any surface, horizontal or other. Its fineness makes it an exceptionally smooth and pleasing paint to apply.

The American Graphite Company, of Cleveland, Ohio, who manufacture this paint under the name of "T. A. G." Blue Lead, say they believe, from the tests which it has withstood, that there can be no doubt that it is a distinct step in advance and the most nearly perfect protection yet attained.

We are interested to learn that the Continental Iron Works, Brooklyn, N. Y., have recently installed a system of alternating current (two-phase) power distribution to replace their former direct current system. Some time ago a small trial system was installed for operating a portion of their machinery by induction motors, as a result of which the new system was installed, including a 180-kw. two-phase alternator, a five-panel switchboard, eleven induction motors of from 5 to 20 h.p. each, with the accompanying auto-starter, all of Westinghouse make. The company some time ago installed an alternator of 120 kw. capacity, and they also have quite a number of induction motors in use driving corrugating and bending rolls for making Morrison fire boxes, also driving fans, shears, tools in the machine shop, etc. Some of the motors which have recently been purchased are to displace direct-current motors, and this after a thorough and careful investigation of the subject and several years' trial of the induction motors. We learn also that the Riter-Conley Manufacturing Company, of Pittsburgh, Pa., has adopted alternating-current motors exclusively for power distribution. They have installed three 200 kw. engine-type Westinghouse generators, direct-connected to Westinghouse gas engines using natural gas. Alternating current motors will be used for all purposes, including cranes, straightening rolls, etc.

BOOKS AND PAMPHLETS.

The World's Famous Railway Trains, British Expresses, Etc. Reprinted from the *Locomotive Magazine*, London. Special series, Nos. 1 to 6. 8 x 11 portfolio, handsomely illustrated. Artistically bound in blue and silver. Published by the Locomotive Publishing Company, Ltd., London. For sale by the Derry-Collard Co., 256 Broadway, New York. Price $1.50.

This volume is a reprint of a series of special illustrated issues of the *Locomotive Magazine* that have appeared at intervals during the last few years. The striking feature of these special editions is the profuse illustrations which present a comprehensive idea of foreign motive-power and rolling-stock practice which it would be difficult to otherwise obtain. The following are the subjects presented in the work: "British Expresses," "The World's Famous Railway Trains," "The British Express Locomotive," "Locomotives of 1900," "Locomotives at Work," "Cars of 1900" and "Locomotives of All Nations." Each subject is treated in a highly interesting manner. All the trains illustrated are from photographs taken when under full speed, while the comparative works upon locomotives and cars show principal dimensions. The typographical work is beautifully executed, the engravings are large and clear, and several colored supplements are included. To those interested in foreign locomotives or in typical railway views we heartily commend this interesting volume.

Continuous-Current Dynamos and Motors, and Their Control. By W. R. Kelsey, B. Sc., A. I. E. E. 440 pages, fully illustrated. The Technical Publishing Company, Ltd., 55 Chancery Lane, W. C., London, 1903. Price 5s.

The first portion of this volume is a reprint of a series of articles that appeared in the *Practical Engineer*, London, for which the author is in no way responsible. In this portion an excellent treatise on the basic principles of electricity is presented. The object of the work is to indicate the ways in which the principles are applied in the design and construction of dynamos and motors. Particular stress is laid upon the mechanical points involved in such work, for which this book is of unusual value. One of the principal features of this book is the very complete treatment of electric traction, with reference to the motors and their gears. Flux-speed-torque curves are presented which are of especial value, and, also, the subject of railway controllers is treated in a very comprehensive manner. This volume will be appreciated by all interested in electric railway practice.

Engineering Contracts and Specifications. By J. B. Johnson. Third edition revised. Fourth thousand. Engineering News Publishing Company, New York, 1902. Price, $3.00.

Typographically this edition, like the others, leaves something to be desired, but this does not very seriously affect the value of the substance. In this revised edition, Part I, "Synopsis of Law of Contracts," and Part II, "The General Treatment of Engineering Specifications and Accompanying Documents," 124 pages, appears to be unchanged. Part III, "Specific Description of Technical Clauses in Specifications," has undergone revision and certain parts have been rewritten, the changes being mainly in the new specifications for "First-Class Masonry," "Cast Iron Water Pipes," "Riveted Steel Water Pipes," "Wooden Stave Pipes," "Wrought Iron Chains," "Street Pavements and Materials" (mainly brick), and "Rules Governing Inspection and Measurements of Lumber in St. Louis." These, in part, are substituted for other subjects, so that little increase in amount results. Part IV, "Illustrated Examples of Complete Contracts and Specifications," show an increase of 130 pages from the first edition and is new in a very considerable degree—although it goes without saying that a number of the old specifications are still so good that nothing better in their line could well be substituted. Altogether the book is distinctively more valuable than the earlier editions. For the frontispiece there is, very appropriately, an excellent portrait of Professor Johnson, whose last work previous to his death by accident was the preparation of the manuscript for this revision.

Fan Motors.—A new catalogue has been received from the Westinghouse Electric and Manufacturing Company, describing and illustrating alternating and direct-current fan motors. It describes a number of types of these convenient machines and by means of excellent engravings impresses the reader with the desire to have one of these upon his desk. Several important improvements are incorporated in the designs presented this year, indicating the characteristic effort constantly made by the Westinghouse Company toward perfection of their apparatus.

Record of Recent Construction No. 41, issued by the Baldwin Locomotive Works, contains photographs of a number of notable trains hauled by Vauclain compound locomotives, constructed at these works. Among the number are the "Atlantic City Flyer" of the Philadelphia & Reading, the "Alton Limited," the "Overland Limited" of the Union Pacific, the "Overland Limited" of the Southern Pacific, the fast mail of the Burlington and a number of other fast and notable trains. It is typographically a very attractive issue of this series, and presents an interesting record of the Vauclain compound in fast passenger service.

"A Portfolio of Rare Views" is a work of art issued by the passenger department of the Boston & Maine Railroad, which forms one of the series of pamphlets of views of beautiful New England scenery on the line of this road. This portfolio contains thirty-three reproductions of photographs of scenery on the Fitchburg division, presenting a panorama of the delightful Hoosac country and Deerfield Valley. It abounds in waterfalls and mountain views of one of the most attractive regions in the world. The title of the pamphlet is "The Charles River to the Hudson." It will be mailed to any address upon receipt of 6 cents in stamps by Mr. D. J. Flanders, general passenger and ticket agent, Boston & Maine Railroad, Boston, Mass. The complete set of six portfolios of views on this line may be had for 36 cents. They are kept upon the library table at the home of the writer of this notice and are thoroughly worthy of such a place because of their beauty and their suggestiveness of the benefits to be had by busy men in outings in God's open air in New England.

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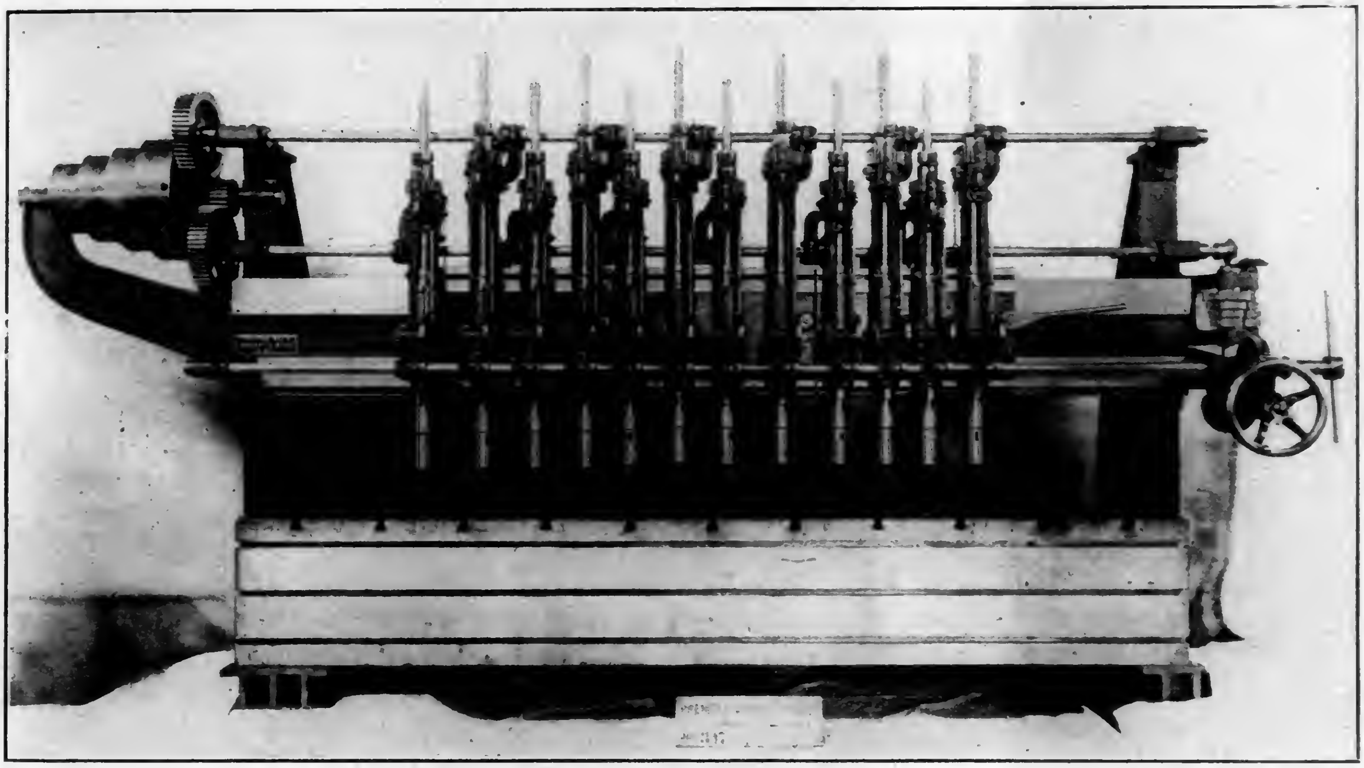
Maximum distance between spindles	8 ins.
Maximum distance betwen outside spindles	134 ins.
Traverse of spindles	14 ins.
Maximum distance, spindles to table	16 ins.
Distance between housings	112 ins.
Distance from floor to top of table	30 ins.
Diameter of spindles in bearings	2¼ ins.
Floor space	212 ins. x 60 ins.
Weight	18,500 lbs.
Capacity	Twelve 1-inch holes in steel



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THE SAFEST PLACE IN A TRAIN.

Under certain circumstances the safest place for a passenger is in the firebox of the locomotive. But the circumstances are important. A locomotive was being hauled in a freight train from the builders' works to be delivered to a Western road, and, as is customary, it was in charge of a messenger. As there was no Pullman sleeper on that freight train, the messenger, according to his habit, rolled himself up in his blanket and bunked in the firebox of his charge, with the grate-bars for a mattress and his boots for a pillow. One night something happened. The train was ditched and his bedroom rolled over, down a high hill and into the valley. Those who saw it said that he crawled out of the fire-door rubbing his eyes and asking why the train stopped so suddenly. Our friend declares that he will never again ride in anything but his bomb-proof stateroom.

Tests of mechanical stokers recorded in a recent issue of *Engineering News* leads a writer in that journal to remark that "it seems that the economy claimed for mechanical stokers in every-day operation is at least open to question. It is certain that before deciding to install any particular one, the purchaser should know just what fuel he wants to use, what its peculiarities are, and how it is likely to act in the furnace under consideration. If too poor in quality it may be impossible to burn it on a chain grate, while if the ash fuses and clinkers badly it may be totally unadapted to other types." The chief difficulty in the tests referred to was the formation of clinkers, which are very difficult to handle in connection with automatic stokers. With coal which clinkers badly it may be actually cheaper to waste a portion in unconsumed state in the ash rather than attempt to burn it all with a high furnace temperature.

Among the passengers on board the White Star liner Celtic recently was a party of officials of the Lancashire & Yorkshire Railway. The party consists of Mr. J. T. Tatlow, locomotive department manager; Mr. G. Banks, freight traffic superintendent; Mr. John Wharton, freight traffic manager, and Mr. F. Dale, chief accountant. The object of their visit is to study the railway situation in the United States. They will spend several weeks on this side, at present stopping at the Waldorf-Astoria.

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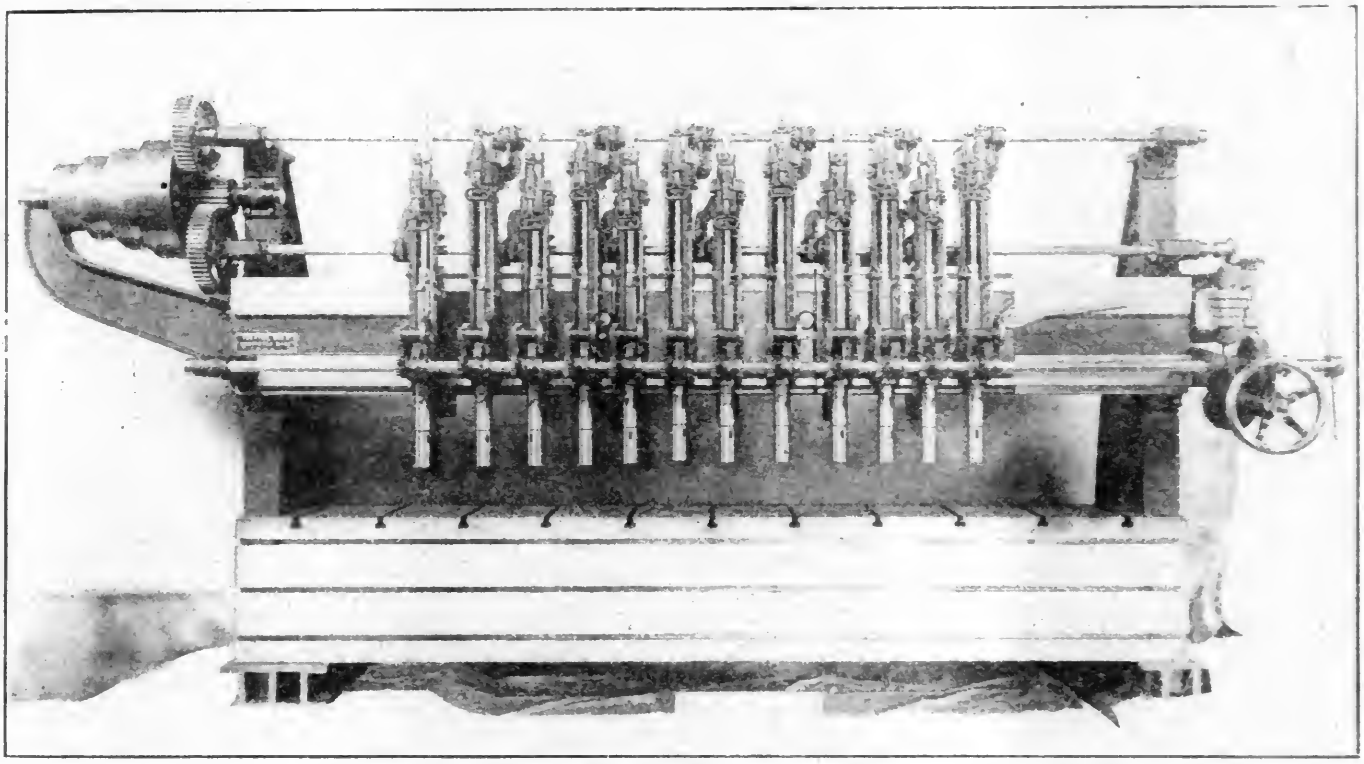

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Under certain circumstances the safest place for a passenger is in the firebox of the locomotive. But the circumstances are important. A locomotive was being hauled in a freight train from the builders' works to be delivered to a Western road, and, as is customary, it was in charge of a messenger. As there was no Pullman sleeper on that freight train, the messenger, according to his habit, rolled himself up in his blanket and bunked in the firebox of his charge, with the grate-bars for a mattress and his boots for a pillow. One night something happened. The train was ditched and his bedroom rolled over, down a high hill and into the valley. Those who saw it said that he crawled out of the fire-door rubbing his eyes and asking why the train stopped so suddenly. Our friend declares that he will never again ride in anything but his bomb-proof stateroom.

Tests of mechanical stokers recorded in a recent issue of *Engineering News* leads a writer in that journal to remark that "it seems that the economy claimed for mechanical stokers in every-day operation is at least open to question. It is certain that before deciding to install any particular one, the purchaser should know just what fuel he wants to use, what its peculiarities are, and how it is likely to act in the furnace under consideration. If too poor in quality it may be impossible to burn it on a chain grate, while if the ash fuses and clinkers badly it may be totally unadapted to other types." The chief difficulty in the tests referred to was the formation of clinkers, which are very difficult to handle in connection with automatic stokers. With coal which clinkers badly it may be actually cheaper to waste a portion in unconsumed state in the ash rather than attempt to burn it all with a high furnace temperature.

Among the passengers on board the White Star liner Celtic recently was a party of officials of the Lancashire & Yorkshire Railway. The party consists of Mr. J. T. Tatlow, locomotive department manager; Mr. G. Banks, freight traffic superintendent; Mr. John Wharton, freight traffic manager, and Mr. F. Dale, chief accountant. The object of their visit is to study the railway situation in the United States. They will spend several weeks on this side, at present stopping at the Waldorf-Astoria.

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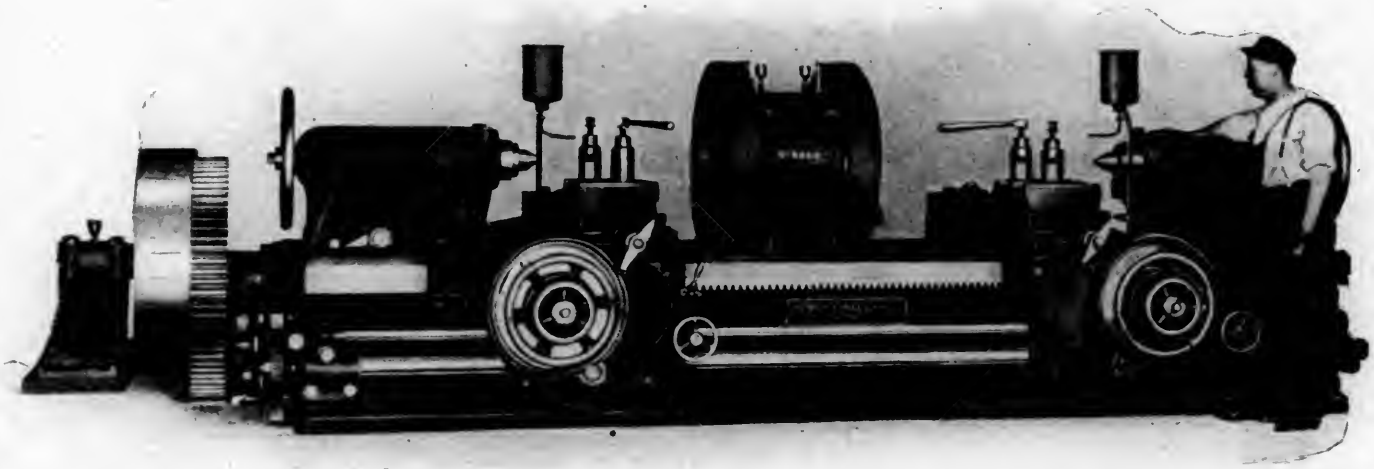

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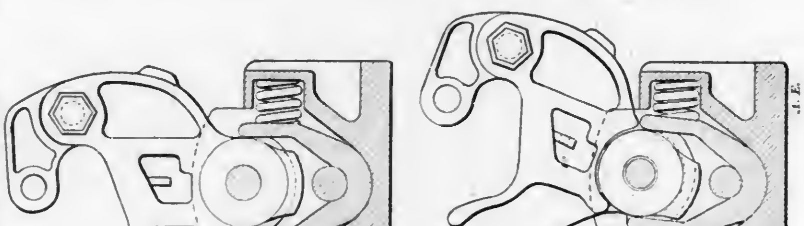

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V.

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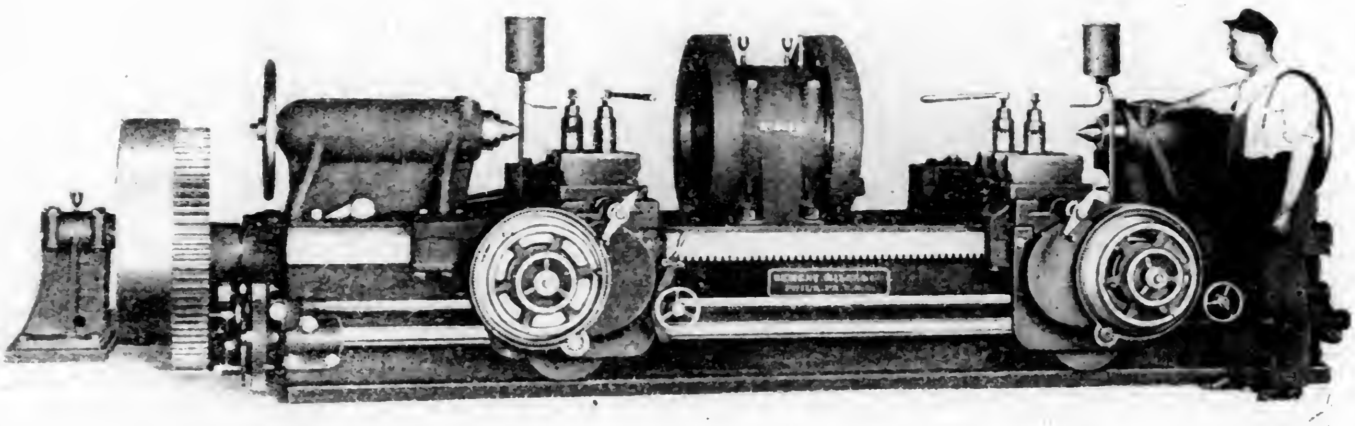

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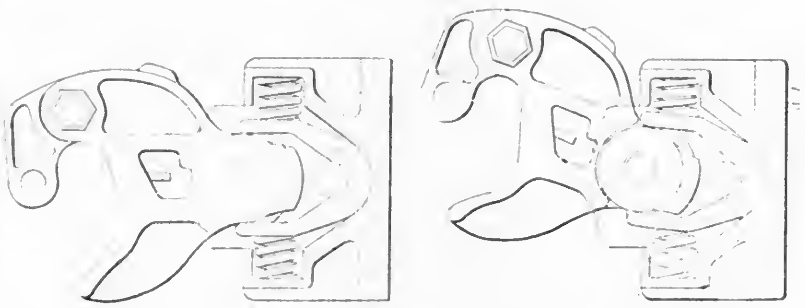

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engaged on both locomotive and car work) are listed, it is found that smith shop floor areas range from 7,500 sq. ft. to 75,000 sq. ft., which limit is slightly exceeded at the new Montreal shops of the Canadian Pacific, where new work, both locomotives and cars, is to be undertaken on a large scale in addition to repair work. Most of our own combination plants, however, show a total smith shop floor area running from 20,000 sq. ft. to 40,000 sq. ft. The exact amount of smith shop floor space for any projected plant can be approximated only after consideration of all the facts bearing on the individual case.

If 20 ft. is adopted as the general head room (where traveling cranes are not used) of one-story structures, there is good reason for increasing it to 22 ft. where swing cranes are in general use, as in the smith shop. At the new Collinwood shop of the Lake Shore the smith shop head room is 24 ft. As swing cranes impose horizontal loads on roof trusses, and as these loads may be in any direction, or all in one direction, it is good practice to proportion the trusses accordingly, and to introduce a good system of horizontal bracing. The new Reading shop of the Philadelphia & Reading has a smith shop which is equipped with a traveling crane covering the entire floor space; this is a decided novelty; there are of course swing cranes as well, supported from the walls. An earth floor is the only practicable one for a smith shop.

The tools list will require great care; hammers from 6,000 lbs. down are used; forges, usually in three sizes, light, medium and heavy; furnaces in assorted sizes from the large scrapping furnace to the bolt and spring furnaces. Trade catalogues will make the way easy for selecting hammers and forges, but there is no authoritative source of information in reference to furnaces, which must be designed in imitation of the best practice which can be located and observed. The ideal fuel for furnaces is gas, which is in common use in steel works, but practically unknown in railway practice except for the single example at the Altoona (Juniata) shop of the Pennsylvania Railroad, where a battery of gas producers supplies all the smith shop furnaces, and one in the boiler shop. The use of oil as a fuel, which is quite common in bolt and spring furnaces in railway shops, is a cheap and acceptable substitute for gas, but is hardly applicable to very large furnaces. Where a great deal of scrap is worked into slabs, enough to keep one hammer occupied, it will pay to have two furnaces to feed it, otherwise the work will be interrupted whenever the furnace requires re-lining or patching, which happens quite frequently.

An examination of the lay-out plans of a considerable number of smith shops discloses the fact that there seems to be no preferred method of grouping small forges for hand work, but the indications are that such forges should be spaced not less than 15 ft. center to center (preferably more), should be ranged along the side of the shop, and stood at an angle to the side wall; this makes the wall available for tool racks, and leaves the finished work lying on the ground adjacent to the gangway, from which it can be gathered up without interfering with the smiths and helpers. Medium and large forges are usually equipped with swing cranes, and can be used to best advantage when located away from walls. The modern smith shop should have both a pressure fan for blast and an exhaust fan to clear away smoke; the down draft system of exhaust has been much used of late, but is susceptible of improvement.

Bolt headers, bulldozers and forging machines are items in the essential equipment of the railway smith shop. These and steam hammers require the use of dies and formers, some of them very heavy; provision should be made for storing them outside the shop, and a hand traveling crane is very useful in this connection.

The general scrap yard should be located near the smith shop, in order that as much wrought-iron scrap may be redeemed as possible. With electric driving available a shear may be located in the scrap yard, and at a few shops a small train of rolls (with heating furnaces) is provided, in order that rods may be rerolled to smaller sizes.

(To be continued.)

STEEL-FRAME, SIDE-DOOR, SUBURBAN PASSENGER CARS.

ILLINOIS CENTRAL RAILROAD.

The most interesting and important development of recent years in passenger transportation equipment is now nearly ready for practical application on the Illinois Central at the Chicago terminal. Eight suburban cars are being built upon a new plan which has been worked out most carefully and completely by Mr. A. W. Sullivan, assistant second vice-president, and Mr. Wm. Renshaw, superintendent of machinery, of this road. The basis of construction is the use of side doors. This necessitated steel under and upper frames and involved a large number of new and difficult problems, all of which appear to have been solved in an admirable manner. When the cars are completed they will be fully illustrated in this journal. We are now permitted to present the theory underlying this development, which we believe to be one of great importance.

At the time of the Chicago World's Fair this road learned the value of the side-door principle in handling 19,000,000 passengers in the most satisfactory service of the kind ever attempted. With the crude side-door equipment in temporary use at that time it was found possible to load 1,000 passengers in 10 seconds and unload them in the same amount of time, without the pushing and crowding incident to such movements in cars of the end-door type, and in contrast with the violent struggles and personal injuries which occur during rush hours on the New York and Brooklyn elevated railroads.

So successful was this method in facilitating train movements that upon one occasion five trains, each carrying 1,000 passengers, were loaded and discharged successively from one platform in four minutes, and this rate of movement could have been maintained longer had not the rush subsided. As it was, the total number of passengers transported on the day of maximum traffic was 509,000, without mishap of any kind.

The concentration of crowds of passengers at the ends of cars is wrong as a transportation principle. It is manifest that a plurality of side doors causes a diffusion of movement, decreases congestion and accelerates progress. If the mean distance traveled is one-half the width instead of one-half the length of a car, the movement will be quicker, aside from the crowding. With side doors ordinary stops may be reduced to from 3 to 5 seconds and a car may be entirely emptied or filled in 10 seconds. Ten passengers will use each door, and this number is independent of the length of the car. A long car may therefore be unloaded as quickly as a short one, and long cars increase the capacity of a train. For unloading 60 passengers from a car having two end doors, 30 seconds are required as compared with 10 seconds for a side door car. If the cars hold 120 passengers this means two passengers per second in one case and 12 in the other, under normal conditions. Doors placed in one side of a car will not cause a troublesome draft in cold weather.

With a side aisle and transverse seats, passengers may enter any door and find seats after the train has started, thus avoiding the delays incident to searching for a seat from door to door, thus equalizing the distribution as in cars with end doors. In this respect this construction is an improvement over foreign practice and also that used at the time of the World's Fair.

With the high acceleration of modern electric service and frequent stops as in large cities, the frequency of train movement will depend for its ultimate development upon the time consumed in station stops rather than that in the movement between stations. The type of cars and character of movements of passengers to and from them will play an important part in the development of the future. Now that the difficulties of construction have been solved the car with side doors seems likely to replace that with end doors.

The accompanying diagrams show only seating plans and are not intended to represent the actual construction. The

diagrams represent a car 65 ft. long and 10 ft. 6 ins. wide which will employ steel framing.

Plan No. 1 is intended for a road with terminal loops, and platforms on the outside of the track, although it may be used without the terminal loops by having the platforms on the same side (east or west) of each track. Plan No. 2 serves the same purpose as plan No. 1, with the further provision that passengers may enter and leave the car on both sides. This plan is intended for use where the platforms are principally on one side, with an occasional island platform on the other side of the track. The capacity of this plan is the same as that of plan No. 1. Plan No. 3 is intended for use where there is considerable travel of moderate volume entering and leaving the car on both sides. The provision of having the aisle extend one-half length on each side, with cross aisle in the middle, is a desirable one where there is no great rush of travel, as it gives the seated passengers the same freedom from passing travel in and out of the car, as does plan No. 1. There is, however, a loss of a few seats by this arrangement, this plan for the small car seating four passengers less than plans Nos. 1 and 2. Plan No. 4, with aisles and doors the full length on both sides of the car, is designed to meet the requirements of the very heaviest travel, with frequent stops at intermediate stations having platforms on both sides of the track.

The weight of the new car per passenger by this construction will be greatly reduced, combined with an increase in the strength of the car beyond that of anything heretofore attained in car construction, as will be seen from the following figures:

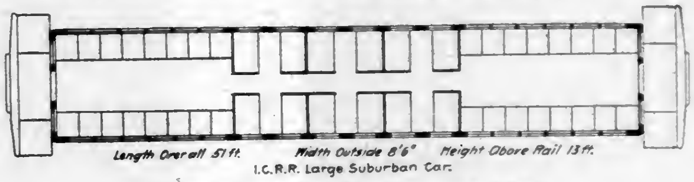
	Length.	Seating Capacity.	Weight.	Weight per Passenger.	Floor Strength. Safe Load per Square Foot.	Floor Strength. Ultimate Load per Square Ft.
Improved suburban car.	65 ft.	120	78,000 lbs.	650 lbs.	160 lbs.	800 lbs.
Regular suburban car..	51 ft.	56	38,000 lbs.	679 lbs.	76 lbs.	380 lbs.
Standard coach	61 ft.	62	86,000 lbs.	1,387 lbs.	81 lbs.	405 lbs.

Upon the Illinois Central Railroad two sizes of suburban cars are at present in use—the small car, which is of the same dimensions as those of the elevated railroads, with seating capacity of 48 passengers; and what is known as the large suburban car, which is 51 ft. long, 8 ft. 6 ins. wide, with seating capacity of 56 passengers.

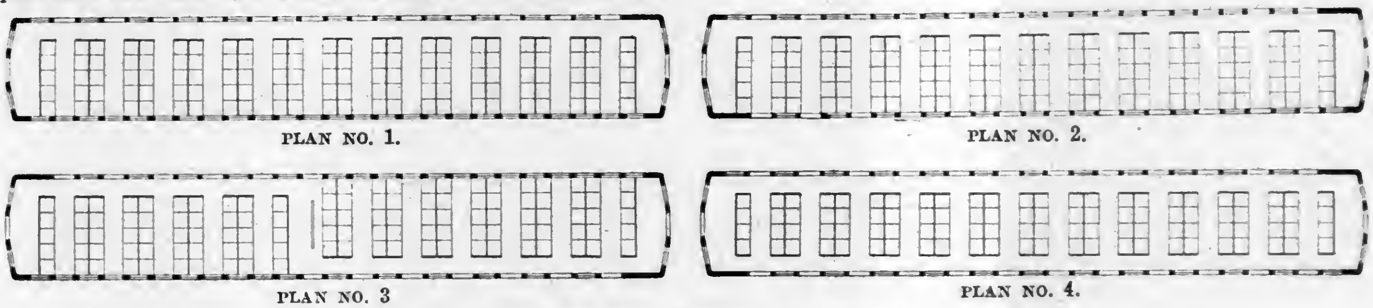
On the Illinois Central it is desirable to increase the size of cars so as to utilize all the space available between the platforms at stations, which has led to the adoption of the width of 10 ft. 6 ins.; and a length of 65 ft. is found to be a suitable one for that service. Some comparisons have been made showing the difference between the cars at present in use and the large improved car. The most noticeable difference is in the seating capacity, which is increased 114 per cent., with an increase of but 27 per cent. in the length of the car. The following table shows the seating, standing and total capacity of the different plans compared with the cars now in use:

	Seating Capacity.	Standing Capacity. Clear of Entrance and Exit.	Standing Capacity. Full.	Total Capacity. Seats, Standing and Clear.	Total Capacity. Seats, Standing and Full.
Plan 1	120	48	60	168	180
Plan 2	120	48	60	168	180
Plan 3	115	53	65	168	180
Plan 4	96	72	96	168	192
I. C. suburban..........	56	0	41	56	97

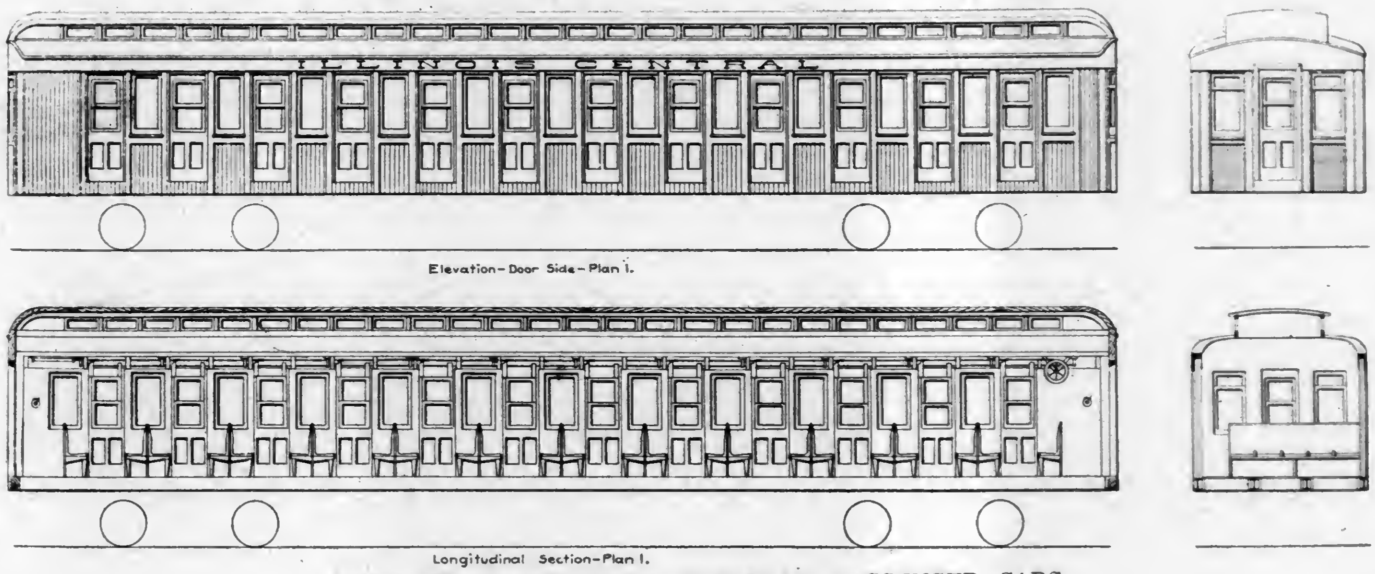
In the matter of standing room there is great advantage to the passengers in that so large a number can stand clear of the entrances and exits. It is also an advantage to avoid having a large group of passengers standing together, particularly when dependent for support upon straps suspended from the roof of the car. The solid group of passengers which can gather in one mass in a car having a wide center aisle will be



PRESENT SUBURBAN PASSENGER CAR.



SEATING PLANS, SHOWING DIFFERENT ARRANGEMENTS.



STEEL-FRAME, SIDE-DOOR SUBURBAN PASSENGER CARS.

BY A. W. SULLIVAN AND WILLIAM RENSHAW.

less able to resist the lunging effect of high rates of acceleration and retardation than when they can individually brace themselves against a rigid support of medium height, and thus avoid discomfort, and frequently the distress that comes from the swaying of such a mass of passengers.

It is of more importance now than ever before that passenger cars should be constructed of the greatest strength, consistent with reasonable weight. To obtain this result, a metal frame work is necessary not only for the floor of the car, but for the walls and roof, in order that when collisions occur, especially at high rates of speed, or when derailments occur and cars rub against the walls of tunnels or other structures, the floor and sides of the car will not be demolished, as is quite likely to be the case with lightly constructed wooden cars.

The greatly increased capacity of the improved suburban car is not due altogether to its larger size, as the following comparative statement shows that per foot of length the new car has 46 per cent. greater carrying capacity than the old:

	Present	Improved Suburban.			
	Suburban.	Plan 1.	Plan 2.	Plan 3.	Plan 4.
Length of cars	51 ft.	65 ft.	65 ft.	65 ft.	65 ft.
Length of cars per cent	100	127	127	127	127
Passengers seated	56	120	120	115	96
Passengers seated, per cent	100	214	214	205	171
Passengers standing	41	60	60	65	96
Passengers standing, per cent	100	146	146	159	234
Passengers, total	97	180	180	180	192
Passengers, total, per cent	100	186	186	186	198
Passengers per foot, seated	1.10	1.85	1.85	1.77	1.48
Passengers per ft., seated p. c.	100	168	168	161	134
Passengers per foot, standing	0.80	0.92	0.92	1.00	1.48
Passengers per ft., stand., p. c.	100	115	115	125	185
Passengers per foot, total	1.90	2.77	2.77	2.77	2.95
Passengers per ft. total, p. c.	100	146	146	146	155

The most noticeable feature of the improved car is the side door, of which in a car 65 ft. long, 12 may be placed on each side for entrance and exit of passengers, in addition to end doors to permit of passing from one car to another. The side doors may be operated either by hand or by compressed air, the controlling mechanism being located within the walls of the car and out of sight. The mechanism provides for the positive opening, closing and locking of the doors by air or by hand. It also provides for closing the doors, locking and unlocking, but not opening them, leaving that to be done by the passengers, which during the season of cold weather would probably be the preferable way. The doors may be operated from either end of the car, and if necessary also from the middle. The quickness with which the doors may be manipulated and the absolute control of them by the trainmen will greatly reduce the time of the stops.

We consider that the door arrangement of these cars possesses especial merit in safeguarding the passengers from personal injury. There being no hand-holds on the outside of the car and no possible means of effecting an entrance when the doors have been closed, there is no temptation nor any opportunity for a belated passenger to get aboard after the train has started; neither is there any opportunity for a passenger to get off the train before it has come to a full stop, because all of the doors are closed by air pressure and can be released only by the trainmen, which will not be done until the train has stopped. All movements, therefore, of entrance and exit can be made only when the train is standing at the station platform, and one of the principal hazards of the service is thus eliminated.

As to the opening and closing of the doors; the walls of the car being hollow and the doors moving between them, there is no chance for a passenger to be caught and injured by them when opened; when closed, the movement, at first rapid, is graduated automatically by air cushions, so that the final closing movement is gentle and safe. Should any portion of a passenger's garment become caught by the door when closing, the elasticity of the air pressure against the door will admit of the garment being withdrawn without injury. Furthermore, the air cylinder for the operation of the doors being quite small, it has not sufficient power to cause injury by its pressure should a passenger inadvertently be caught in the doorway when the door is closing.

The transverse arrangement of seats, with side aisles and doors, made possible by the metal construction used, permits the car to be made of the greatest width for the distance between the tracks. Upon important terminals, where land values are high and traffic dense, there is need for the most complete utilization of available space, and when combined with the wide car of maximum seating capacity the quickest possible movement in loading and unloading passengers is effected by means of side doors, the conditions necessary to the development of the ultimate earning capacity of the property are attained so far as such conditions are dependent upon the vehicle of transportation. The introduction of this type of car is destined to mark a new era in the development of rapid passenger transportation.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

IX.

TESTS OF CUTTING SPEEDS, SHAPES OF TOOLS, HEAT TREATMENT,

In connection with the motor-driven machinery of these shops, a systematic study of machine-tool operation is being made, and at this point an account of tests of cutting speeds with high-speed tool steels is introduced in the series of articles. These tests were carried out by Mr. H. H. Vaughan, assistant superintendent of motive power.

The intention at first was to make a comparative test between various makes of steel, determine which of them gave the best results in service and ascertain what could be expected in regular work. Mr. Vaughan soon decided, however, that the first thing to do was to take one brand that showed good results and make sufficient experiments with that to determine what could be expected, and then endeavor to carry out the results in the shop, leaving the comparison between one steel and another until later. It is not so important to obtain the small percentage of increase of output that one good steel can give over another, as it is to obtain the greatly increased output that several of the new high-speed steels can give over the old water-hardening steels.

It will be noticed that the tests were all made with 1-10-in. feeds. The feed is one of the factors affecting the cutting speed in any tool and material, the cut being the other; to state at what speed a cut can be taken, it is necessary to also specify the feed and depth of cut. In the majority of locomotive work the cuts do not appear to vary sufficiently to affect the question very much, but the amount of feed is a different matter and is very important. By adopting a constant feed for all roughing work as far as possible, this variable, which is the most difficult to deal with, is eliminated.

This system is being introduced at the Collinwood shops with very satisfactory results, as the cutting problem at once becomes very simple and can be watched by practically noting the speed at which the work is running.

The machine used during all the experiments was a Pond 28-in. engine lathe, direct driven by a motor of 7½-h.p., which could be temporarily overloaded to about 12-h.p. All tools were ground in a Sellers universal grinder, permitting them to be ground accurately to any desired angles.

The series of experiments were made upon three classes of material—axle steel, wrought iron, and cast iron—to determine the proper cutting-speed, feed, and depth of cut to be used, as well as the best methods of treating the steel, and the correct angles for grinding. A lateral feed of 1-10 in. was at once adopted as being satisfactory for most classes of work. A coarser feed would be very severe upon the point of the tool, and many cases may arise requiring a finer feed, depending upon the character of the work.

The question of the most efficient depth of cut is one which cannot be definitely answered from the data at hand, because the power of the driving motor did not permit a cut to be taken which was at all near the capacity of the tool. By varying the cut through the range possible the indications were

that the life of the tool at a constant feed and cutting speed was independent of the depth of cut. This is reasonable, for although the work of removing the metal increases directly as the depth of cut, after the point of the tool is buried, the cutting edge provided to do this work is increased a like amount. The remaining points must be taken up separately.

MEDIUM STEEL.

On axle steel the preliminary tests of Styrian tool steel, run dry with the tool ground with 5-deg. end rake and 25-deg. side rake, showed a well defined limit of cutting speed at about 45 ft. per minute, beyond which it was impossible to go without very quickly ruining the tool. At 48-ft. per minute the tool lasted 12½ minutes with a 1-10-in. x 3-16-in. cut, being very hot all of the time, the chips coming off a deep blue. It seemed reasonable to suppose from the endurance of the tool while hot that if the heat generated by cutting could be absorbed and carried away before it had time to heat the tool, the life of the tool would be greatly prolonged, and the cutting speed might be increased.

A water jet applied above the work would not accomplish this result on account of the water not coming into contact with the tool at the cutting edge. So a ⅛-in. copper tube connected to an elevated cask was carried along the tool rest on the leading side, the end directed upward toward the point of the tool at an angle of 45 degs., and through this was forced a mixture of lard oil, resinous soap and water, at various heads up to 12 ft. The above mentioned location of the jet was found to have the greatest cooling effect upon the tool, and splashed the least water; the results obtained from this arrangement of the water jet leave no doubt as to the advantages to be derived from its use on steel work. Other conditions being the same, a tool which burnt in 15 minutes running dry will run with the water jet for an hour or more in good condition. It is necessary to use just enough water to carry away the heat.

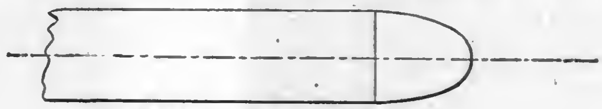
It is a rather remarkable fact, however, that the maximum safe cutting speed with a water jet is practically the same as without. The explanation is probably this: When tools have been removed from the lathe after cutting with the water jet, they have all been found more or less blue for a narrow strip along the cutting edge, showing that the water had not reached the extreme edge of the tool, even when applied under considerable pressure. At speeds up to 45 ft. per minute the body of the tool conducts the heat away from the edge rapidly enough to prevent overheating, but at higher speeds this action is not fast enough and the local temperature rises to a point which weakens the steel so that the side clearance is worn away, spoiling the tool.

A very thorough investigation was made of the proper angles at which to grind the tools. The results indicated that a tool with small side rake would last somewhat longer than one ground at a greater angle, on account of the stronger backing of the cutting edge, the difference being greater when running dry than with a water jet. But the action of the tools in removing metal is that of a continual shearing in a plane nearly perpendicular to the top face of the tool. For a given feed the area over which this shearing takes place is much greater for a flat-topped tool than for one with considerable side rake; hence, the power required to drive a flat tool is correspondingly greater.

This statement is verified by the fact that the chips from a flat-topped tool are blue and wear deep into the top of the tool, even with a water jet in use, while those from a thin-edged tool are not discolored and the tool is not worn, a great advantage in regrinding.

On a continuous cut, with the water jet, it was found entirely safe to use a side rake angle of 35 degs. to the horizontal, cutting 40 ft. per minute, but on an intermittent cut, the edge is likely to be nicked, causing overheating; so for average use an angle of 25 degs. is recommended. Using this sharp angle with the nose of the tool ground symmetrically brings the point very low. So it is recommended that the nose be ground at an angle of about 15 degs. to the shank, as shown in the accompanying sketch, which has the effect of raising the point, and makes a much easier running tool.

Tools hardened in oil showed an endurance nearly 100 per cent. greater than when hardened in the air blast. The best results are produced by heating a small portion of the end of



Tool with Symmetrically Ground Nose.

Nose Ground at angle of 15° A.E.

the tool to a bright red and cooling in oil. This makes a hard edge, but does not harden the body of the tool, leaving it tough, and making a tool adapted to heavy service. The only objection to oil hardening is that it sometimes cracks the tool, although seldom so seriously as to impair its strength.

WROUGHT IRON.

For the proper speed of cutting wrought iron no definite figures can be given, as this depends almost entirely upon the amount of slag in the iron. On good clear iron speeds of over 80 ft. per minute can be maintained easily, with a 1-10-in. feed and 3-16-in. cut, using a 25-deg. to 30-deg. tool and a water jet, but a piece of cinder is apt to ruin a tool at once, even when running as slow as 40 ft. per minute.

The indications are that a speed of 60 ft. per minute will generally be found satisfactory, using a water jet, with tools ground and hardened the same as for steel.

CAST IRON.

On cast iron, excellent results were obtained from tools hardened by being heated to a welding heat and cooled beside the fire. Such a tool will not hold a fine enough edge for finishing, but for roughing cuts on medium iron, it will far outwear an oil tempered tool. The side rake angle recommended for these tools is 15 degs. They may be run safely at from 45 to 55 ft. per minute, depending upon the density of the iron. If much scale is to be cut, 40 ft. is the highest safe speed. Light finishing cuts with oil hardened tools may be run as high as 85 ft. per minute, with a fair degree of accuracy.

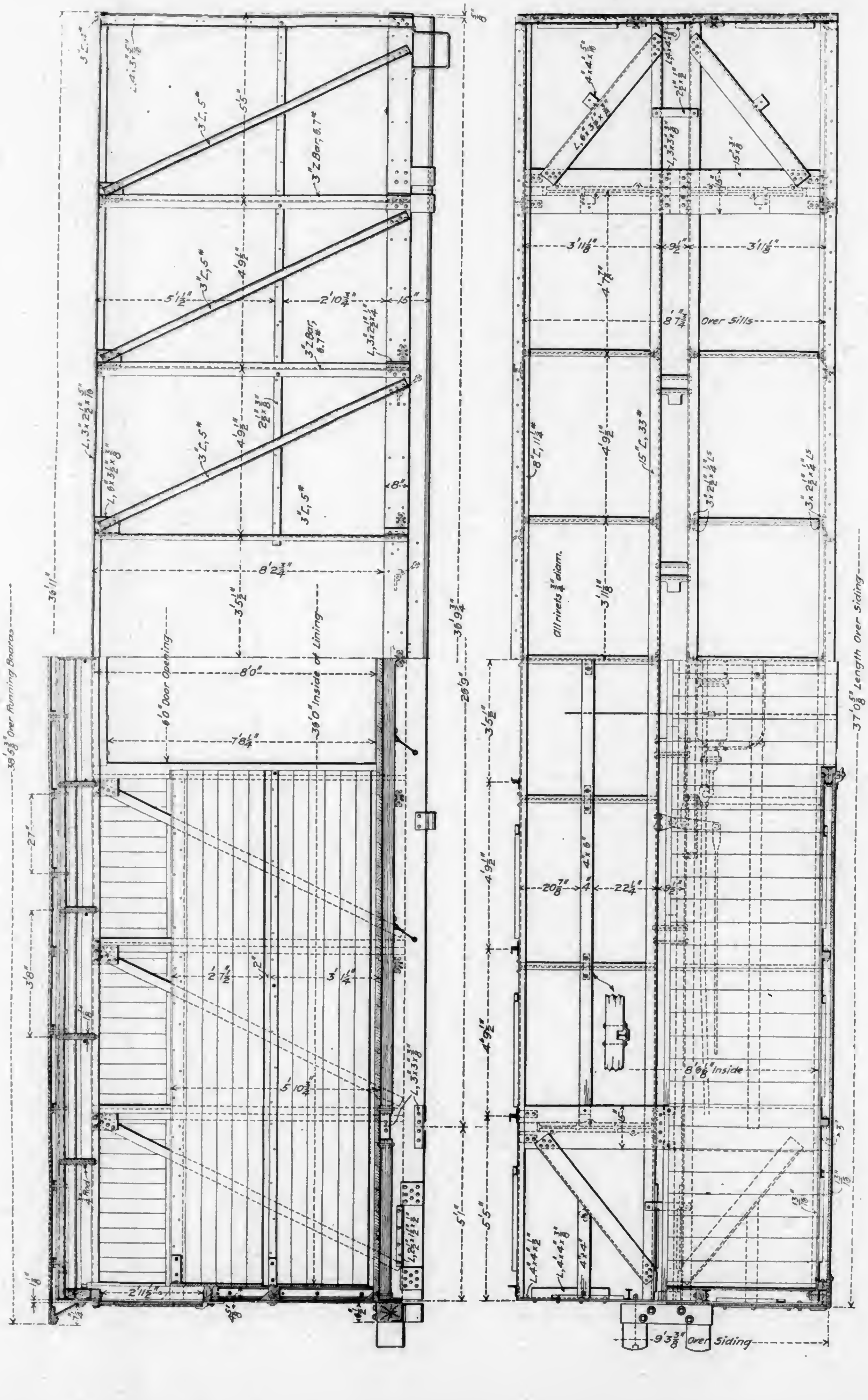
Cutting-off tools should be oil hardened and will last longer if the sharp corners are removed. They will stand a speed of 40 ft. per minute, but the cross feed allowable varies from .012-in. to .025-in., depending upon the hardness of the iron. If the feed is kept at the upper limit and the cutting speed is reduced, the tool will not last as long as with the high speed and finer feed.

Electrical measurements of power showed that a roughing tool working upon cast iron would absorb, without breaking down, only about 50 per cent. as much power as a tool of the same hardness cutting clean wrought iron, both being ground to suit the material worked upon. Coupled with the fact that a piece of slag in a wrought iron cut will ruin a tool with no increase in the power required, this indicates that the life of a cutting tool is dependent upon the character of the metal it is cutting as well as upon the power absorbed.

It is known that a tool applied with considerable pressure to a slow speed emery wheel will burn much sooner than if applied more lightly to the same wheel running faster. Working upon a material such as cast iron, whose action upon a tool is similar to that of an emery wheel, some benefit may result from the use of a high speed with a fine feed and consequent low pressure against the side of the tool. But in the case of wrought iron and steel, although no data on the subject are at hand, it is not probable that the increase of speed possible would compensate for the reduction in the feed.

Following is a tabulation of the principal results of the tests:

Material.	Form of Tool.	Angles. Side Rake.	End Rake.	Clearance.	Speed. Ft. Per Min.	Feed. Ins. Per Rev.
Axle steel.....	Roughing.	25°	10°	8°	35 to 45	.10
Wrought iron..	Roughing.	25°	10°	8°	35 to 80	.10
Cast iron......	Roughing.	15°	10°	8°	45 to 55	.10
Cast iron......	Cutting-off.	0°	0°	8°	40	.012 to .025



A STEEL-FRAME BOX CAR—BY C. A. SELEY.

STEEL FRAMES FOR CARS.

A STEEL FRAME BOX CAR.

BY C. A. SELEY.

MECHANICAL ENGINEER CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

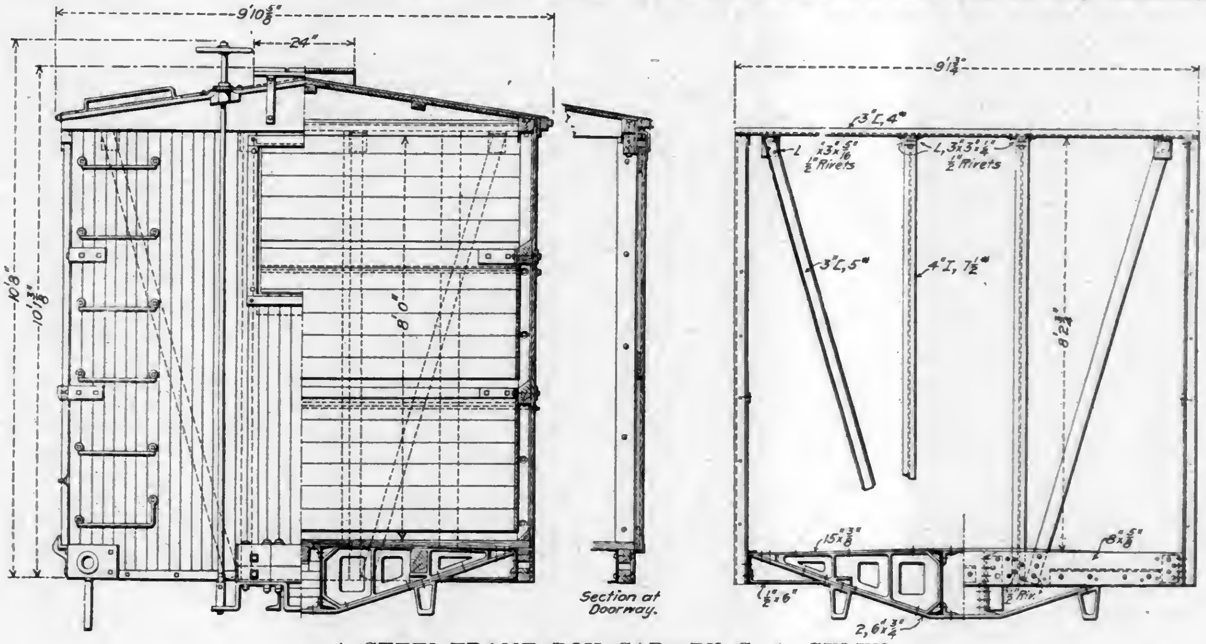
In answer to an inquiry from the editor of the AMERICAN ENGINEER, "Has the time arrived when it is good business policy to discard wood in favor of steel for car underframes?" I wish to say from the mechanical and designer's standpoint, that steel has thoroughly demonstrated its usefulness, not only for underframes, but for side and end frames as well, and the only steel underframe car that I would advocate would be a flat car. The AMERICAN ENGINEER has kept the railway world well informed in regard to car designs and, among others, the composite cars built by the Norfolk & Western illustrate my argument.

The frames of these cars, which are the carrying members, are of steel; the bodies, which serve merely to retain the load, and this supposition has been borne out by the performance of the cars, now nearly two years in service.

Some roads have reinforced their weak, wooden side framing by introducing steel channels or Z bars to resist lateral bulging under load. As these are not combined with the frame and are not under vertical stress they have only their own inherent lateral strength and are an expensive addition. The majority of box cars have comparatively weak ends and the amount of repairs on this account is very great, and has been much increased of late years, due to severe shocks in switching and the greater weight of modern cars. Some roads have used steel in the ends of box and stock cars with great advantage as a strengthener and no expedient in wood construction can equal the strength gained thereby.

The accompanying engravings illustrate a study in steel frame box car design for a car of the American Railway Association standard dimensions, viz., 36 ft. x 8 ft. 6 ins. x 8 ft. Some modifications of the Norfolk & Western design are here shown, which may or may not be of advantage.

The side posts are Z bars with an easy connection top and



A STEEL-FRAME BOX CAR—BY C. A. SELEY.

are of wood, a material lighter and cheaper than steel, lasting its natural life, easily repaired and maintained. These cars are very staunch, of light weight, and consequently carry a high percentage of revenue load, besides having other advantages not necessary to take up at this time. These designs embrace gondola, hopper and box cars and their success proves the designer's contention that it is not necessary, in these cars at least, to provide the carrying strength in the underframing. The sides of gondolas and hoppers offer an opportunity for a truss, to be made of the side framing, that will carry any desired load without truss rods under the car. In the cars referred to the trussed sides carry nearly half of the load, the remainder being carried by center sills. It is not believed that the scheme of relieving the center sills of load and using light members for the pulling and buffing trusses only is the better one.

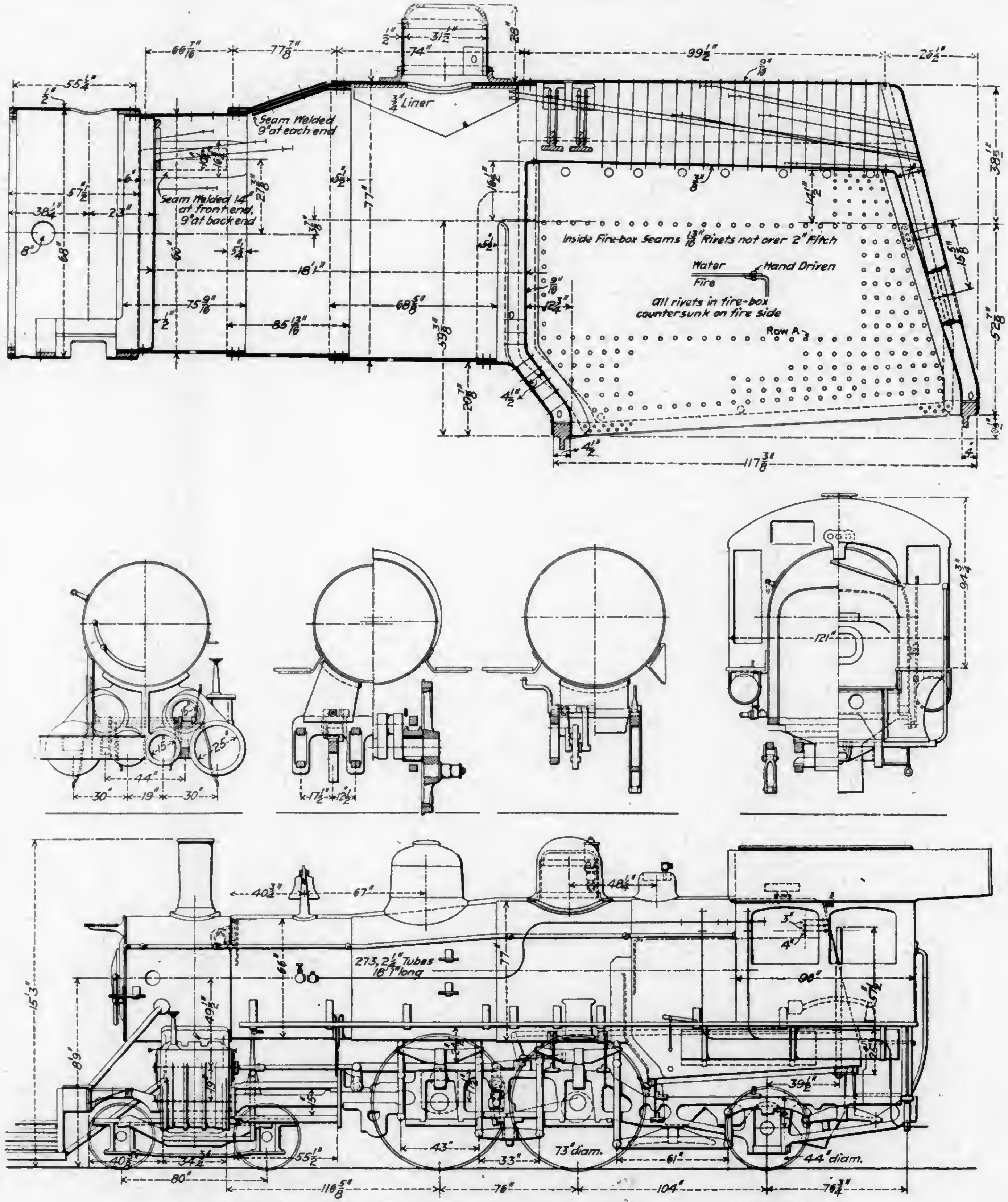
Box car designing offers a less inviting field for the use of steel as the side door opening interrupts the truss and it is not possible to put diagonals in the doorway to make it complete. Notwithstanding this, 100 box cars were built on the Norfolk & Western Railway in 1901 which have given excellent service. These cars have complete steel frames up to and including the side and end plates, and were illustrated in the AMERICAN ENGINEER in May, 1902. The only doubt the designer had in reference to these cars was in regard to the ability of the sides to resist bulging with a flowing load, as of grain. The posts and braces were mainly of 3-in. channels and it was believed that when stressed by a heavy load that the tension members would be aided thereby to resist deflection laterally bottom, and being the tension members, they will resist very considerable lateral stress, their cross section being considerably in excess of the vertical requirements for strength. The flooring rests directly on the sills instead of on furring strips, and sufficient nailing strips are provided for center, intermediate and end nailing. Instead of sectional side girths a through girth of iron with wooden blocking is provided for the bottom girth, and the upper girths are as usually provided in wooden cars. An outside steel roof is provided. No particular draft gear is meant to be suggested, the provision shown merely indicating that the draft is to come direct to the center sills.

The upper framing shown has several strong points. The ends are very strong and will not give away readily to the pounding of a shifting load. The sides are strong to resist lateral bulging under flowing loads. The vertical strength of the center sills and side framing is sufficient to carry a load of 88,000 lbs. without undue deflection, and, in fact, the vertical deflection of the sides of these cars is not noticeable under full loads.

An incidental point of advantage in cars with steel truss sides is their stiffness to resist racking of the body and roof, and this will lessen in a marked degree the necessity for renailing the siding and roofing, a class of repairs much called for with weak superstructures.

Now, as to whether the use of steel as above described is justified as against the use of wood is clearly one of the markets and delivery and not of mechanical adaptability. There are manifest advantages in favor of steel in the way of reduc-

tion of dead weight which contributes to the carrying of an increased percentage of paying loads, also a reduction of maintenance charges due to the structure being stronger and better able to resist shocks and loosening from wear. In case of wreck there is a great amount of salvage, as bent and twisted members can be straightened and used again; whereas if of wood a renewal is required. In heavy repairs of wooden cars the new material cost will run from 60 to 75 per cent. of the total, while if steel is used the labor cost will be represented by the above figures; leaving but 25 to 40 per cent. as the cost of new material required, and in composite cars this is mainly for lumber and not steel. All these points should be carefully weighed and credited against the increased cost of a steel car over a wooden one, and if properly appreciated the writer believes that not only steel underframes, but side and end frames for all classes of cars are fully justified.



VAUCLAIN FOUR-CYLINDER BALANCED-COMPOUND LOCOMOTIVE

ATCHISON, TOPEKA & SANTA FE RAILWAY.

G. R. HENDERSON, *Superintendent Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

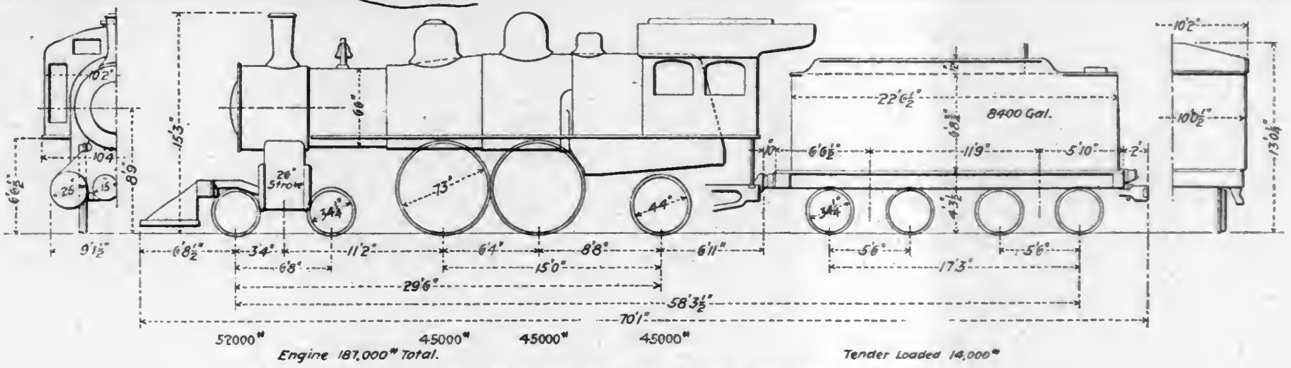
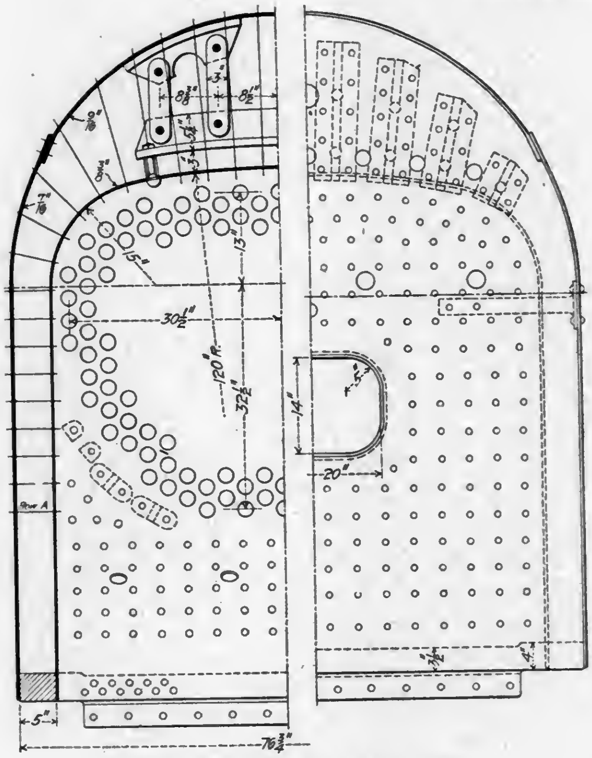
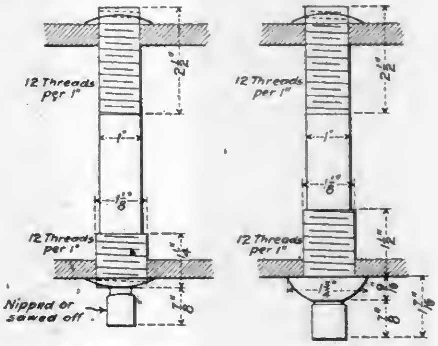


DIAGRAM OF LOCOMOTIVE AND TENDER.



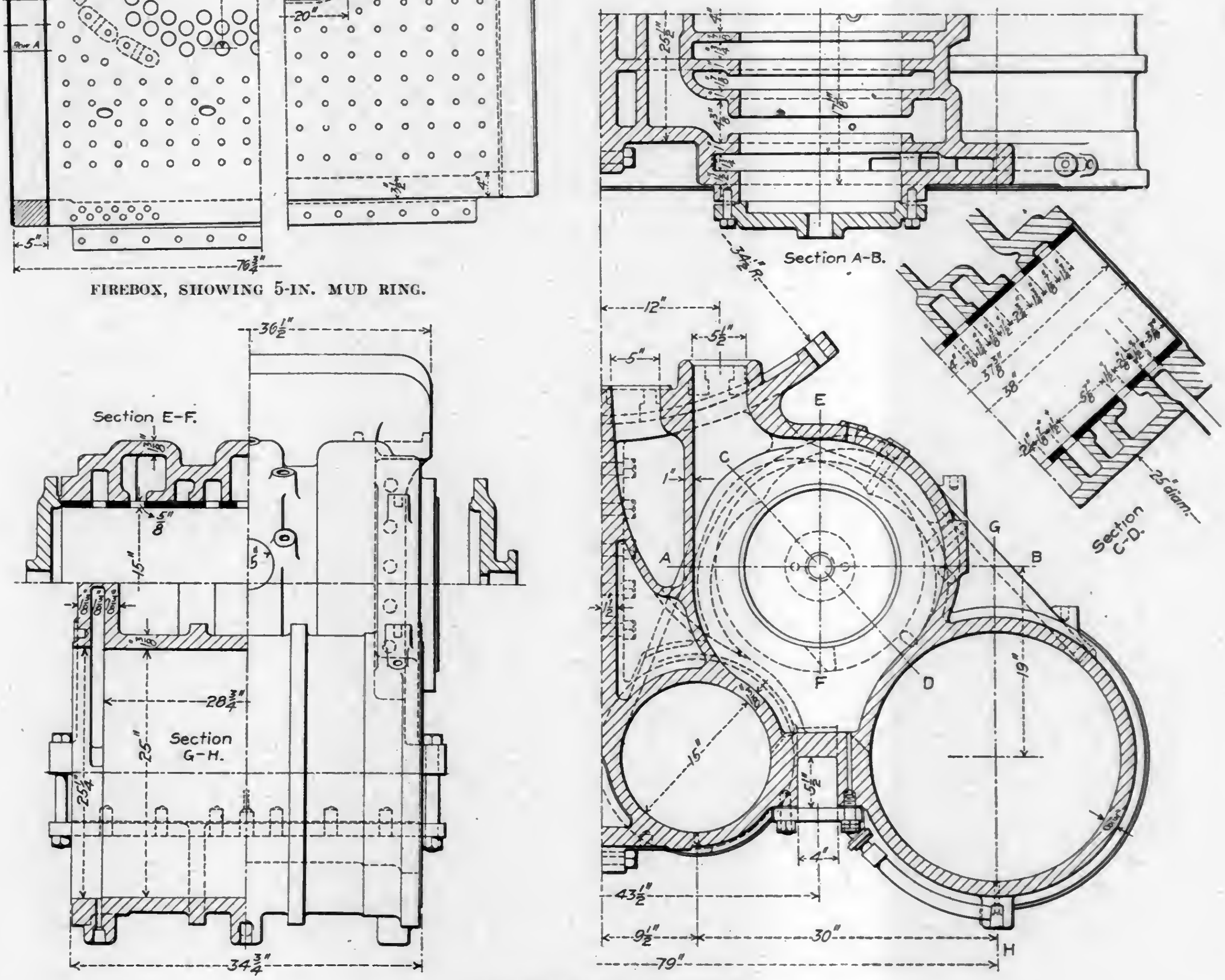
FIREBOX, SHOWING 5-IN. MUD RING.



Style No. 1. ROWS OTHER THAN CENTER.

Style No. 2. CENTER ROWS.

CROWN STAYS.



CYLINDERS AND STEAM CHEST.

VAUCLAIN FOUR-CYLINDER BALANCED-COMPOUND LOCOMOTIVE.

ATCHISON TOPEKA & SANTA FE RAILWAY.

G. R. HENDERSON, *Superintendent Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

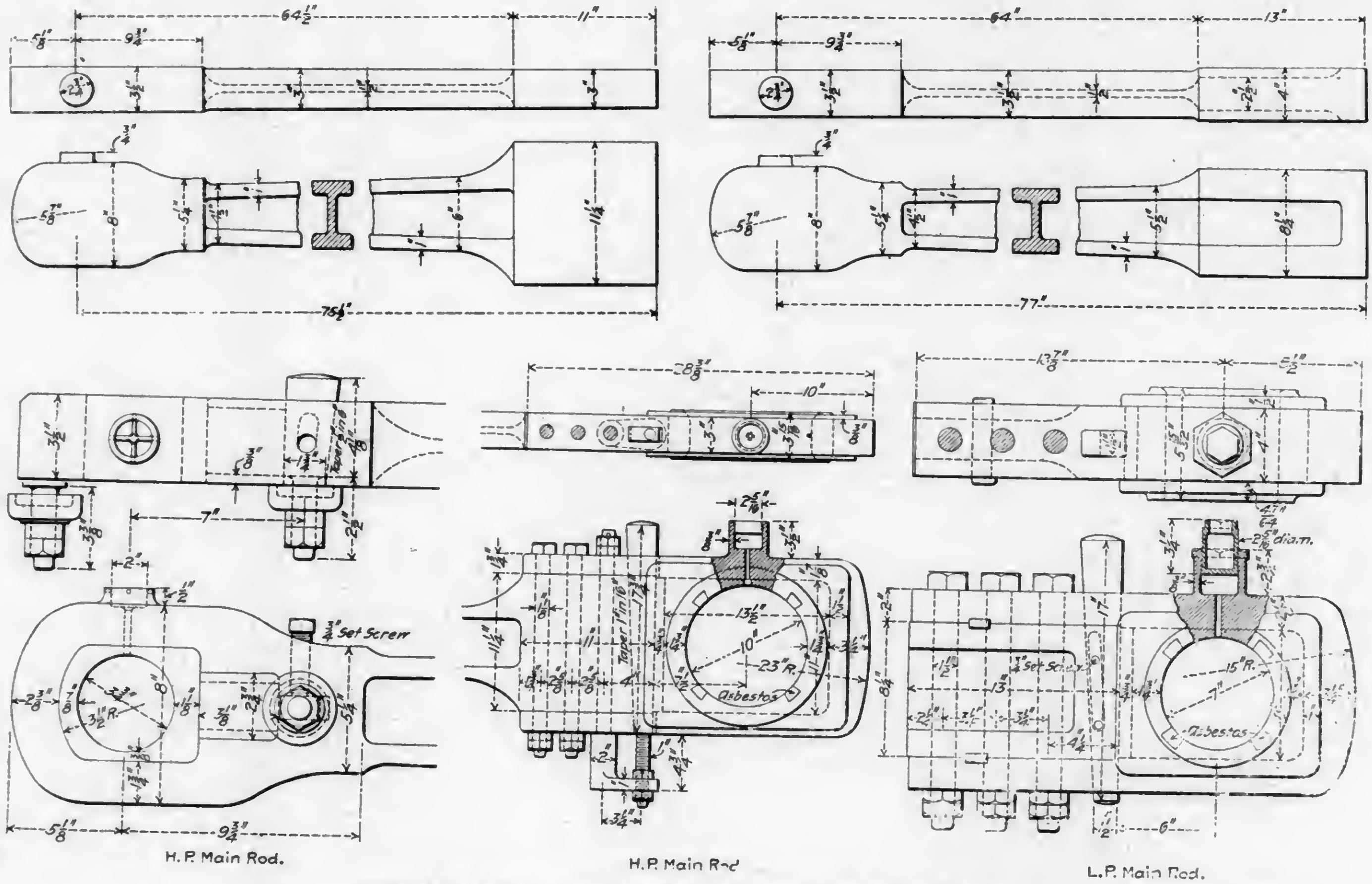
COMPOUND PASSENGER LOCOMOTIVES, 4-4-2 TYPE.

Vauclain Four-Cylinder Balanced System.

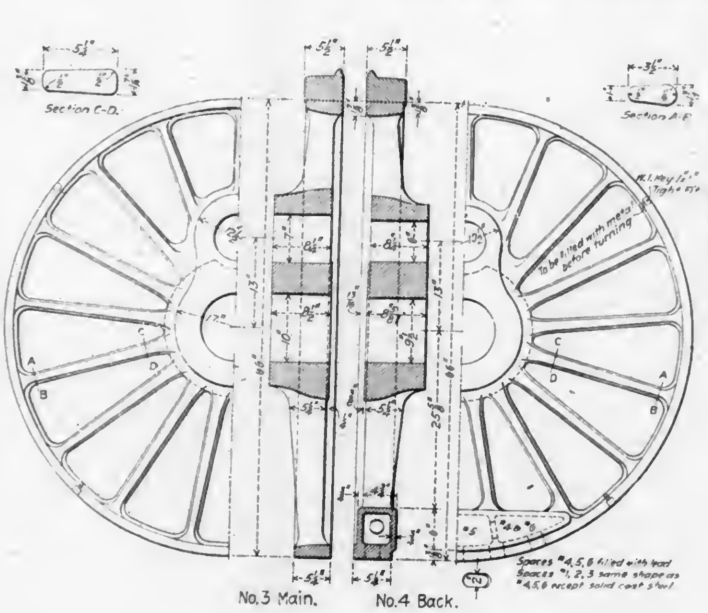
ATCHISON, TOPEKA & SANTA FE RAILWAY.

The Baldwin Locomotive Works are building, to their own design, four balanced compound locomotives for passenger service on the Santa Fe. Mr. G. R. Henderson, superintendent of motive power, has given his permission for the publication of this description.

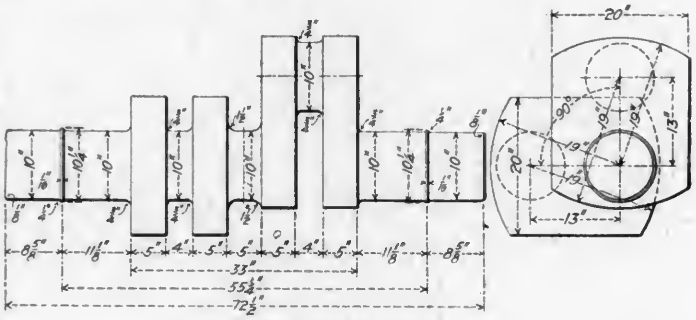
These engines are similar in many respects to the Plant System engine (American Engineer, March, 1902, page 72). These are of the four-coupled type and have cylinders exactly like those of the earlier engine except as to minor details. The tractive power of the new design is 24,000 lbs. when working as a compound and the cylinders are approximately equivalent to 18.9 in. simple cylinders. The weight on drivers is to be 90,000 lbs., but with the balanced construction, undoubtedly a much greater weight than this can be placed on these wheels without more—and probably very much less—injury to the track than would be caused by a locomotive of the usual sys-



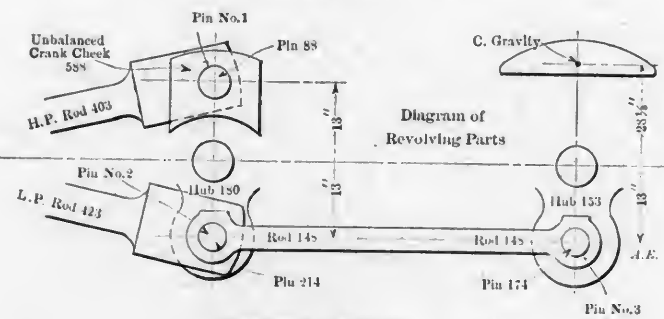
THESE DRAWINGS ILLUSTRATE THE LIGHTNESS OF THE RODS.



MAIN AND REAR DRIVING WHEELS.



THE CRANK AXLE.



COUNTERBALANCING.

VAUCLAIN FOUR-CYLINDER BALANCED-COMPOUND LOCOMOTIVE.

ATCHISON TOPEKA & SANTA FE RAILWAY.

G. R. Henderson, *Superintendent Motive Power.* Baldwin Locomotive Works, *Builders.*

tem of counterbalancing. The writer has long held the opinion that a self-balanced engine offered an opportunity to greatly increase the weight on driving wheels and thus obtain in the best possible way the advantages of a traction increaser which would be available all the time and yet not subject the track to more punishment than it now receives with the prevailing wheel weights. The advent of this construction upon a road like the Santa Fe is an event of great importance. We hope it marks a turning point in the development of American locomotive practice in favor of good balancing, the best possible use of steam and a division of the stresses among a larger number of parts of the running gear, which may therefore be made lighter and actually reduce repairs and failures.

Among the engravings is a preliminary diagram of the locomotive with its tender, which is a large one, carrying 8,400 gals. of water. The boiler is of the wide firebox type for coal burning. The mud ring is 5 in. wide at the sides, to assist circulation. While the tubes are 18 ft. long, the heating surface is 500 sq. ft. less than that of the 4-4-2 type locomotives on the New York Central. One of the drawings illustrates the crank axle, which differs in many respects from that used on the Plant System engine. The main bearings are 11⅛ x 10 ins., the crank pins 10 x 4 ins., the wheel fits 10 x 8⅝ ins. and the crank webs 20 in. wide by 5 in. thick.

The method of balancing and the remarkably light weights employed are clearly indicated in the sketch and the drawing of the driving wheels. A summary of the revolving weights referred to in the sketch is as follows:

REVOLVING WEIGHTS.

Pin No. 1. Inside.	Pin No. 2. Outside.	Pin No. 3.
lbs.	lbs.	lbs.
403	423	...
588	180	153
88	214	174
...	148	148
1,079	965	475

This leaves 1,079, minus 965, or 114 lbs. excess revolving weight on the inside of the main wheel. The reciprocating weights are as follows:

RECIPROCATING PARTS.

	Inside.	Outside.
Piston	356	463
Crosshead	310	310
Main rod on crosshead pin	149	156
Totals	815	924

This leaves 929, minus 815, or 114 lbs. of reciprocating weight in the main wheel. The 114 lbs. of reciprocating weights are balanced in the main wheel by 114 lbs. excess revolving weight inside the main wheel, thus requiring no counterbalance in that wheel. The balance for 475 lbs. is required in the rear wheel and this is accomplished by a weight of 208 lbs. with a radius of 28½ in., as indicated in the diagram.

Ratios.

Heating surface to volume of high pressure cylinders	= 571
Tractive weight to heating surface	= 29.7
Tractive weight to tractive effort	= 3.75
Tractive effort to heating surface	= 7.92
Heating surface to grate area	= 61.3
Tractive effort × diameter of drivers to heating surface	= 578.
Heating surface to tractive effort	= 12.6%
Total weight to heating surface	= 61.7

VAUCLAIN 4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Gauge	4 ft. 8½ ins.
Cylinder	15 and 25 x 26 ins.
Valve	Balance piston
Boiler—Type	Wagon top
Diameter	66 ins.
Thickness of sheets	11/16 and 13/16 ins.
Working pressure	220 lbs.
Fuel	Soft coal
Staying	Radial
Firebox—Material	Steel
Length	107 15/16 ins.; width, 66 ins.
Depth	front, 75⅞ ins.; back, 67⅜ ins.
Thickness of sheets	sides, ⅜; back, ⅜; crown, ⅜; tube, 7/16 in.
Water space	front, 4½ ins.; sides, 5 ins.; back, 4 ins.
Tubes—Material	Iron; wire gauge No. 11
Number	273; diameter, 2¼ ins.; back, 4 ins.
Heating surface—Firebox	190 sq. ft.
Tubes	2,839 sq. ft.
Total	3,029 sq. ft.
Grate area	49.4 sq. ft.
Driving wheels—Diameter outside	73 ins.
Diameter of center	66 ins.
Journals	main, 10 x 11 ins.; others, 9 x 12 ins.
Engine truck wheels—Diameter	34¼ ins.
Journals	6 x 10 ins.
Trailing wheels—Diameter	44 ins.
Journals	8 x 12 ins.
Wheel base—Driving	6 ft. 4 ins.
Rigid	15 ft.
Total engine	29 ft. 6 ins.
Total engine and tender	58 ft. 3½ ins.
Weight—On driving wheels	90,000 lbs.
On truck, front	52,000 lbs.
On trailing wheels, estimate	45,000 lbs.
Total engine	187,000 lbs.
Total engine and tender, about	327,000 lbs.
Tank—Capacity	8,400 gals.
Tender—Wheels	No. 8; diameter, 34¼ ins.
Journals	5½ x 10 ins.

STEEL UNDERFRAMES AND STEEL CARS.

A BUSINESS QUESTION.

Does it pay, from a business standpoint, to build cars of 80,000 lbs. capacity and over with wooden underframes?

The Baltimore & Ohio Railroad Company.
Office of General Superintendent of Motive Power.

If I had to pay for equipment out of my own pocket, I would certainly build cars of forty tons capacity and over, with metal underframes. From personal observation, I am satisfied that the life of a car with wooden frames, no matter how strongly built, will be very short; also that it will suffer considerable damage when mixed with steel cars in the long and heavy trains that are hauled by modern locomotives. That the cost of repairs of steel cars will be less than that of wooden cars I have no doubt whatever, and the experience we have had so far confirms this view. Of course, cars with steel underframes have not been in service as long as is the case with wooden cars, and when they advance in age the cost of maintenance will undoubtedly be greater than it is during the first few years of their life. I think, however, it is perfectly safe to predict that the final cost will be considerably less for the steel cars than for the others.

F. D. CASANAVE,
General Superintendent Motive Power.

New York Central & Hudson River Railroad.
Office of General Superintendent Motive Power, Rolling Stock and Machinery.

I would say in a general way, that I think we cannot much longer delay the use of the steel underframe, and it also looks as though the upper structure of cars would tend toward steel.

J. F. DEEMS,
General Superintendent Motive Power, Rolling Stock and Machinery.

Erie Railroad Company.
Office Mechanical Superintendent.

The time has passed when steel construction should be considered experimental. I cannot indicate, however, that for cars of 80,000 lbs. capacity we should yet depart from wood underframes, as the first cost and type of construction have appealed to me as good practice up to the present time. For anything over 80,000 lbs. capacity we are in favor of encouraging and adopting steel for underframes. The greatest objection to steel construction in the past and, I may say, even at the present time, is in the design and arrangement for securing the box to the steel underframe in box cars. We think, however, that this can be overcome, and the 100,000-lb capacity car of the future should embody in its make-up, so far as possible, a type of metal construction, which, from our point of view, is quite as essential in a box car as in other cars.

W. S. MORRIS,
Mechanical Superintendent.

Southern Pacific Company.
Office of General Superintendent Motive Power.

We have as yet had no personal experience with steel cars, although we are now having some 3,100 cars built with pressed steel underframes. I believe the steel underframe has come to stay. At a meeting of the motive-power officers of all of the Harriman lines, now in session here, after considerable discussion of this matter it was decided to adopt steel underframes for all future freight equipment. H. J. SMALL,
General Superintendent Motive Power.

Chicago, Milwaukee & St. Paul Railway Company.
Office of the General Superintendent.

My experience and observation in the matter of metal underframes for cars are not sufficient to express a decided opinion. With the cars with which I have had experience I would say that the maintenance of the metal underframe is materially greater than without. It is possible and, I think, probable that it is more a matter of design, and I question whether the details of design are yet sufficiently worked out and demonstrated, but there are several cars of various designs in service now, and I think they will enable us to settle this question in the course of a few years. J. N. BARR,
General Superintendent.

Grand Trunk Railway.
Office of Third Vice-President.

In view of the fact that this company has not operated any steel cars or cars with steel underframing, I am unable to speak from any personal experience. Our opinion is that it is economy to construct cars up to and including those of a capacity of 40 tons, of wood, but that on cars with a capacity of more than 40 tons, it would prove economy to use the steel underframing; and in coal cars, where the car is a hopper, self-clearing type, steel throughout is desirable. As this company now has on order steel cars of 50 tons capacity, we will be able later on to speak from practical experience.
FRANK W. MORSE,
Third Vice-President.

The Delaware, Lackawanna & Western Railroad Co.
Office of Superintendent Motive Power and Equipment.

I would say that, as a general proposition, the time has arrived for substituting steel for wooden construction in the underframe of all cars of 40-ton capacity and over. In regard to the box cars, of which I have any knowledge, built with the steel underframe, I think the wooden sills now used as a foundation for the box of the car are too light. We have had several cars of this type in our shops for repairs, and found the wooden sills on top of the steel underframe had split, and, in my opinion, if these cars had a combination Z-bar and 4 x 8-in. outside sill for holding the frame of the box, the car would be very much improved. T. S. LLOYD,
Superintendent Motive Power and Equipment.

The Chicago & Alton Railway Company.
Motive Power Department.

Our standard for all box, furniture, stock and refrigerator cars of 60,000 lbs. capacity and over is steel underframing.

After a test of nearly four years we have come to the conclusion that the steel underframing is a decided success, and in my opinion, with steel cars, equipped with strong and suitable draft gear and steel trucks, very little, if any, running repairs will be needed. My experience has been that it is almost impossible to construct a draft gear on a wooden car which will withstand the shocks and strains to which a car is subjected in the heavy tonnage trains of to-day. I realize that serious objections have been raised to the steel sides and floors on gondolas on account of corrosion. This is not, in my opinion, as serious as is claimed; nor will the corrosion equal the running repairs that are necessary on wooden cars. At any rate, the corrosion objection cannot be made against steel underframing. A. L. HUMPHREY,
Superintendent Motive Power.

Atchison, Topeka & Santa Fe Railway.
Motive Power Department.

I think there is no question but what steel underframes are specially desirable for large capacity cars. With cars of less than 80,000 pounds capacity it is practically impossible to design a steel underframe which will be as light as the ordinarily adopted wooden frame, but when the capacity reaches 80,000 pounds it can be done without difficulty, and as the capacity is still more increased the advantage will be unquestionably with the steel underframing. The ordinary freight cars in this country adapt themselves very conveniently to steel underframing, and there have been hopper bottom gondolas, drop bottom gondolas, box cars, and practically all varieties built with this framing. With stock cars it seems in a measure undesirable on account of the drippings from the cars having an action upon the metal parts and tending to quickly corrode them, but there are very few stock cars that are built of over 60,000 pounds capacity. We have very little information that would show us positively the advantage in dollars and cents of the steel frame car over the wooden car in the way of repairs, but we know from experience that under ordinary service and with the ordinary care in protecting them from rust and corrosion that the frames will last very much longer than wooden frames, which are subject to decay and checking. The heavy pulling strains induced in the drafts of freight cars by the large locomotives of the present day more than ever make this type of car desirable, and particularly as center sills can be obtained of sufficient depth to embody the draft rigging and also to take the pressure from the buffer blocks, when cars are so provided. Taking all points into consideration, we think there is no question but for large capacity cars—that is over 60,000 pounds, and some times with 60,000 pounds—the advantages are greatly in favor of the steel frame car. G. R. HENDERSON,
Superintendent Motive Power.

——— Railroad.
Office of Superintendent Motive Power.

I hardly believe that the subject is open to discussion. The experience all roads are having who are using the large steel 100,000 lbs. capacity cars is that they are very hard on the lighter wooden cars, and the only way I see in which we can permanently save our lighter cars is by substituting steel center sills with the same heavy draft gear as used on our 100,000 lbs. capacity cars. We are doing this at the present time in our 60,000 lbs. capacity coal cars. It costs us quite a little money, but we nevertheless feel that we are justified in doing it, as the only salvation the old wooden car has is in having the same strength through the center sills and draft gear that the heavier car has. In other words, I do not believe it is possible to design a car and have things in proportion to the capacity of the car, but believe that the center sills and the draft rigging have got to be made the same on the 60,000 lbs. capacity car that we have on the 100,000 lbs. car if we expect them to run in the same trains and stand the same hard usage. It is only one step further to substituting an entire steel underframing for all cars. This we intend to do in all new work, and in all repair work where the cars are running in trains that have the heavy 100,000-lb capacity cars in right along. On the ——— ——— Railroad we have no box cars over 80,000 lbs. capacity—and comparatively few of them—so that it is not immediately necessary to go into the steel underframing in this class of car, although all new cars that we are having built are built on these lines. With the coal car the situation is entirely different, as we run solid trains from the ——— and ——— regions to tide water, and a large percentage of the cars in these trains are the regular 100,000 lbs. capacity steel car, and it is becoming very apparent that the life of our ordinary wooden car is going to be very much reduced unless the matter is taken in hand very promptly and steel center sills substituted for the present wooden construction.

— — ———,
Superintendent Motive Power.

The Pittsburgh & Lake Erie Railroad Company.

Unquestionably the steel underframe is a good thing, but I believe that it is neither necessary nor economical to use it under cars of less than 80,000 lbs. capacity. We believe that cars of 40,000, 50,000 and 60,000 lbs. capacity can be built on wood frames of sufficient strength and at a much smaller cost, but for any heavier capacity it is undoubtedly wise to use steel underframes. These remarks are purely an opinion, and are not based on actual observance. While this company has a large equipment of all-steel cars, we have none with a steel underframe only.

L. H. TURNER,
Superintendent Motive Power.

New York Central & Hudson River Railroad Company.

[EDITOR'S NOTE.—This letter was written before Mr. Waitt severed his connection with this road.]

In my opinion, the time has not come to take the position absolutely that steel should be substituted for wood for underframes of cars. I think, however, that such a change is desirable and is in the line of ultimate economy. Personally, I am so well convinced of the desirability of this change that I should have no hesitation in recommending and advocating the steel underframe on new freight cars of 40 tons capacity and over. Experience is rapidly being developed with steel underframes which will undoubtedly clearly demonstrate that, even with slightly greater first cost, the net result due to less expense in repairs, and greater value of scrap, is decidedly in favor of the steel underframe. The steel underframe can be designed to give lighter weight with greater strength, and the steel sills can be protected so as to reduce the depreciation from corrosion to a small feature, which, as compared with decay of wood, will show the advantage in favor of steel. A steel underframe makes possible much greater stability in design for draft rigging, which in wooden cars is a source of heavy expense for repairs. In designing cars with steel underframes particular attention should be given to providing for good protective features against corrosion. If steel is given a protective coating, care should be taken in the design to prevent friction from slight moving of parts which would in any way destroy the coating. It is also desirable to as far as possible give easy access to as much of the metal as possible for inspection, cleaning and painting. In conclusion, I believe the steel underframe is the coming type, and that it is coming to stay.

A. M. WAITT,
Superintendent Motive Power and Rolling Stock.

Burlington & Missouri River Railroad in Nebraska.
Office of Superintendent Motive Power.

I have come to believe that the steel car is much better than the wooden construction. The steel underframing has much in its favor. It appears to me that the steel underframing will last for an almost indefinite time under box cars. The draft rigging can be attached in a more rigid and permanent way on steel cars than is possible on wooden construction, and with the present double-spring rigging the annoyance and cost of repairs due to failure of draft rigging should almost entirely disappear. Of course, cars are not built to be wrecked, but the experience with the steel underframe cars has shown that they are not nearly so easily damaged in a wreck as are the wooden cars. I am in some doubt as concerns the steel underframing for coal cars. The question here seems to me to be whether the wooden sill will rot out quicker than a steel sill will rust out. In the case of coal cars, both classes of sills are exposed to the weather. On the whole, I believe that the steel underframing is also the most desirable in coal cars. It does not seem to be so much a question of the desirability of steel underframing, but rather how soon can we get them and get ourselves in shape to take care of them. I am very strongly in favor of an underframing made of merchant shapes. I believe cars built of these shapes are cheaper to repair than those made of special sections, and again, the material can be obtained more readily.

R. D. SMITH,
Superintendent Motive Power.

——— Railroad.
Office of the General Manager.

We are preparing designs of steel underframes for the various types of our freight cars as rapidly as possible, with the intention of eventually using the steel underframe construction for all new cars. As this is an evolution as a result of a number of years' study and experience, it is about as good evidence as you could have that in our judgment it is a good business proposition to discard wood for steel for underframes.

— — ———,
General Manager.

Burlington & Missouri River Railroad in Nebraska.
Office of Assistant General Superintendent.

It seems to me that for a great deal of freight the concentration of loads into fewer units is so advantageous from a train-tonnage and traffic-handling standpoint that there can be little question as to the wisdom of using steel members for underframes. Steel bridges have entirely taken the place of wooden bridges, and I believe that, with the heavier loads and with the consequent heavier shocks that our equipment now receives, steel underframes will undoubtedly be regarded in future as the proper material for most of our freight-car equipment.

G. W. RHODES,
Assistant General Superintendent.

Canadian Pacific Railway Company.
Mechanical Department.

I referred your letter in connection with steel car construction to our master car builder, and he has answered me as follows:

"I would say that in my opinion steel underframes, with or without truss-rods, are very desirable for freight cars of 40 tons capacity or over. Wood is becoming more difficult to obtain every year, and when obtained is almost always unseasoned and more or less defective, and in consequence the floor frames of all classes of freight cars lose shape as well as strength, and deteriorate very rapidly. It would appear from the great demand for steel floor frames at the present time that the only reason they are not more extensively used is the difficulty of obtaining them fast enough. The steel-frame car has shown its reliability as well as its ability to withstand severe shocks and derailment, and in view of the fact that repairs to it amount to nothing except in cases of accident or derailment, any reasonable expenditure in this direction is in the line of economy. The pressed steel frame, being practically the pioneer, is in very extended use, and would appear to be very desirable as long as it keeps out of trouble, but when from any cause the frame becomes distorted it appears to be an absolute necessity to return the car to the builders for repairs. The steel floor frame built from merchant rolled sections, while possibly more expensive at the outset and somewhat heavier, obviates these objections. But there have been many mistakes made in building steel frames, on account of improper distribution of material. In addition to this, there have been many mistakes made in the way of unnecessary dead weight. There is no doubt in my mind, however, that the steel floor frame has come to stay, and that the freight car of five years hence will have not only steel floor frames but quite likely steel upper frames. In connection with the steel floor frame, a good friction draft rigging should make it possible to operate cars with practically no repairs. The greatest enemy the steel floor frame has at the present time is rust, and with the many efforts now being made to secure something that will prevent this, there can be no doubt that science will produce something which will remove this last objection and make the steel floor frame an unqualified success."

I will add that I fully concur with Mr. Fowler's views in this matter. We have casually considered the question of steel underframes for our future new equipment, but we have decided that for the present at least we will not change from wood construction.

E. A. WILLIAMS,
Superintendent Rolling Stock.

Michigan Central Railroad Company.
Office of Superintendent Motive Power and Equipment.

In my opinion, the underframes of 50-ton cars and upward should be made of steel. In regard to 40-ton cars, I am not sure. Figures from the manufacturers show that our 40-ton box car would cost from $100 to $125 more per car with steel than with wooden underframes. I am inclined to think that the difference in the cost of maintenance would not warrant this.

E. D. Bronner,
Superintendent Motive Power and Equipment.

Seaboard Air Line Railway.
Office of Superintendent Motive Power.

It was my privilege to be one of the pioneers in the matter of steel car frames for freight-car use, excepting the Harvey car, and the pipe-framed car, neither of which designs was successful, owing to the fact that they were principally based on a substitution of metal for wood, following the original design and pattern intended for a wooden car, and without due reference to the proper use of steel. The result of much investigation and close study on this subject has led me to feel positively certain that the underframes of all cars of 80,000 capacity and over should be built of steel, for the following reasons:

The steel frame made out of commercial shapes is lighter than the timber trussed frame of equal strength. The steel frame has less deflection under load and is not so easily distorted. The strength of the steel frame is not seriously interfered with by shrinkage, as is the case with the wooden frame. The steel frame, when properly constructed, does not require tightening up, but when once riveted together is complete for all time, barring accident. For hopper and gondola cars I believe strongly that the side framing should also be of steel, and I believe in the use of steel end posts in box cars, but do not believe in steel side trussing for box cars. With steel frames a better and more elastic draft gear is desired than with the wooden frames, to save the couplers from injury, as the harshness of the blow is much greater when struck by a rigid steel-framed car than by a wooden car, where the sills will yield a trifle at the instant of contact. Experience has shown that cars with properly built steel underframes cost very little for body repairs, and that the investment of a small amount of money in such metal underframes pays a handsome interest in reducing the cost of maintenance.

R. P. C. Sanderson,
Superintendent Motive Power.

Maine Central Railroad Company.
Office of Superintendent Motive Power.

My experience with steel cars, and also with cars of over 30 tons capacity, is limited, since the road with which I am connected owns no such cars. We have, however, at the present time a good many foreign cars, both of large capacity and of steel construction, running over our road, and since almost all of them are practically new cars, they give us very little trouble. Almost all the wooden cars of 40 tons capacity are box cars, and thus far I do not see that they are developing any such weakness as would justify the conclusion that all wooden construction is unfit for box cars of this capacity. Almost all the flat and gondola cars of over 30 tons capacity which we handle have steel underframes, and we have not yet found that these steel underframes require any repairs. My own feeling in the matter is that a well-constructed wooden box car of 60,000 to 80,000 lbs. capacity will give excellent satisfaction and prove durable under existing conditions of service. In spite of the hard treatment to which freight cars are subjected in freight yards, I do not find that our own 30-ton capacity wooden box cars built in the last three years are going to pieces in a serious way, and I question whether the very considerable difference in cost of the higher capacity box cars with steel underframes is justified by the difference in the cost of maintenance. In the case of gondola and flat cars, it seems to me that the question is very different. It may be possible to build a wooden flat car which will successfully withstand the treatment to which cars are subject, but I am doubtful in regard to it, and I believe that a good steel flat car is distinctly a good investment to-day. Where the conditions of service make hopper or self-discharging coal cars desirable it seems to me that the higher capacity steel car is the proper thing, although the question of expense in maintaining the steel superstructure of coal cars is one which requires more experience and careful consideration.

P. M. Hammett,
Superintendent Motive Power.

——— & ——— Railroad.
Office of Master Car Builder.

I have not yet taken very kindly to steel cars, and especially to that class of steel cars that carry coal. I think none of them have been in service long enough yet to test their economy as compared with a first-class wooden car. I mean so far as concerns the deterioration of the metal caused by sulphur, acids, rust, etc. It is barely possible that our railroading in this section is not severe enough to pay the extra cost of metal cars, and that may bias my opinion somewhat. I certainly believe that a metal car, so long as it does not seriously rust or become weakened by sulphur or chemicals, will, in the same class of service, be maintained at a lower cost of repairs than the ordinary wooden car. Time will tell whether or not I am right on this subject. I have no objection to your making use of this letter, except that I do not wish its author quoted.

— — ———,
Master Car Builder.

Butte, Anaconda & Pacific Railway Company.
Office of Vice-President and General Manager.

Our experience in the handling of copper ores and smelter supplies has taught us that a wooden car will not stand up under the tests necessary to subject them to. We use the pressed steel cars of 100,000 lbs. capacity for ore and other smelter material, and do not find any noticeable deterioration by reason of corrosion. We paint interiors of cars used in flue dust service. The only serious problem in the use of large-capacity steel cars is the development of sharp flanges, caused by the sagging of bolsters, the load being carried on side bearings and preventing proper curvature of trucks. The distance between side bearings has been increased, but does not afford the necessary remedy, as in the course of a few weeks the bolster sags to its old position. We are experimenting with different forms of side bearings that will engage the load but permit proper curvature of trucks. Whether or not we can solve the problem is entirely a matter of conjecture.

M. S. Dean,
Vice-President and General Manager.

——— Railroad.
Motive Power Department.

While we have not been users of metal underframing to any extent, we have had considerable experience with it on cars belonging to other companies, and from what I have seen of it, I am firmly of the opinion that the time has not arrived for such a change, excepting the use of metal for center sills only. We have used wooden underframing with metal center sills to a very great extent with complete success. I believe it would be to the interest of railroad companies to construct certain classes of freight cars with steel center sills in the wooden underframe, such metal sills to be so arranged that the strains of pulling and buffing will come in direct line with the couplers. There are other classes of cars, such as ore cars, which are very short in construction, and can be built cheaper with wooden underframe, which, if properly constructed, taking the corrosion into consideration, will, I believe, outlast the metal underframe made of present weights. We have had 200 50-ton capacity ore cars in service since April, 1900, and in the following year the number was increased to 600, all having wooden construction throughout, and up to the present writing we have spent practically nothing for maintenance of these cars. As to box cars: I think it a well-established fact that wooden sides and intermediate sills will, barring accident, last from twelve to twenty years, and metal sills will become

useless from corrosion before this length of time. Where metal underframes are used in the construction of a box car I know of no way the braces can be applied to perform the same service given in wooden underframe cars. Where the latter are properly constructed the camber is put in with the braces, and the seasoning of the sill and plate will bring the settlement on the braces, but it will not settle below a straight line, and the upper part of the car is therefore held firmly in position. This feature cannot be obtained where the underframing is of metal, because there is no camber in the car when built, and when the roof-plate and the wooden rests for posts and braces season a little there will be no settlement, as in the case of the wooden underframe car, and the consequence is that the braces become loose, allowing the top portion of the car to work, and this working and racking is very detrimental. The roof, sides, doors, floor, posts, braces and, in fact, the whole portion of the car above the sills, as well as the couplers, springs, followers, draw-lugs, trucks, bolsters, air-brakes and fittings, will depreciate as much where the underframing of the car is of metal as it will in the case of a wooden underframe, so that the only portion on which the depreciation will differ will be in the underframing itself.

— — ———,
Master Car Builder.

——— & ——— Railroad.
Office of Superintendent Motive Power.

I think we have arrived at the time when the wooden underframing will be largely superseded by steel from the fact that with engines of tractive power running from 40,000 to 60,000 lbs. it is impossible to get a satisfactory wooden structure to stand the racket induced by such heavy strains either in tension or compression; even if the wooden underframing construction is to be perpetuated it would seem as absolutely necessary that some central member of steel be embodied in that construction to provide for the longitudinal strains of tension and compression. If a railroad is entirely circumscribed with its own business and does not interchange, and the motive power is not of the increasing capacity of the day, a wooden underframe construction might be perpetuated, but for interchange business all over the country I believe that a wooden underframe in new construction will soon be a thing of the past.

— — ———,
Superintendent Motive Power.

Chicago Great Western Railway.
Office of Superintendent Motive Power.

I have had no experience with steel underframe cars of any capacity, nor wooden cars of a capacity greater than 35 tons, and not having an accurate distribution of cost of maintenance of wooden cars under 40 tons, I have some hesitation in attempting to answer the question.

To consider the question as related to 30 and 35-ton cars, it may be assumed that wood and steel underframe box cars have the same light weight; that wooden cars cost $800 and steel underframe cars $950; that depreciation of a wooden car is 5 per cent. and of a steel car 3 per cent. per annum; that the cost of maintenance of wooden cars of good construction is as follows:

	Material per car year.	Labor per car per year.	Total per car per year.	Total per 100 miles.
Sills	$ .50	$ .50	$1.00	.014
Couplers	1.00	.50	1.50	.022
Draft timbers	1.50	1.00	2.50	.036
D. B. pockets	.70	1.30	1.00	.014
Other repairs and wrecks	....	....	15.00	.214
Total	11.00	10.00	21.00	.300

It is also assumed that the breakage of steel sills will be less than that of wooden sills, but that on account of greater rigidity there will be more broken couplers with steel sills and that it will be necessary to paint steel sills more frequently to prevent corrosion; that the cost of maintenance of the steel cars will be the same as that of the wooden cars, less draft timbers and sills, or say 25 cents per 100 miles; that the average mileage of wooden cars in service (that is, not held for repairs) is 7,300 miles per year; that 5 per cent. of the wooden cars are constantly on the repair track; that the number of steel cars on repair tracks is less in proportion as repairs per mile are less, or say 4 per cent. Therefore, an investment in 1.05 wooden cars, or $840, is necessary, and in 1.04 steel cars, or $988, to make 7,300 miles per year. Therefore, we have for the wooden car:

$840 at 10% (5% interest and 5% depreciation)	$ 84.00	
Repairs, 7,300 miles at 30 cents	21.90	
Total		$105.90
And for the steel cars:		
$988 at 8% (5% interest and 3% depreciation)	$ 79.04	
Repairs, 7,300 miles at 25 cents	18.25	
		97.29
		$8.61

a saving in favor of steel car per year of $8.61, or about 8 per cent.

It would seem from these figures that the percentage of total repairs to be saved by use of steel underframes is too small and uncertain to justify the additional investment of 20 per cent. in first cost in cars of 30 and 35-ton capacity. As the capacity increases I presume the cost of maintenance of wooden cars would increase more rapidly than that of steel cars, and that there would be a farther saving in the use of steel cars by reason of their lighter weight for a given capacity. The loss by wrecks is no doubt less with steel cars on account of less cars totally destroyed, but there are no doubt a good many cases of partial damage where broken sills are easily replaced, whereas bent and distorted steel sills are expensive to straighten or renew. Experience with steel tender frames, steel trucks and steel brake-beams indicates that corrosion is quite rapid unless they are kept painted. The damage to underframing of wooden cars is largely due to concentration of shocks at the center sills or draft timbers, and I believe that the serviceability of wooden underframing can be materially improved if the jerks and blows can be more uniformly distributed to all the sills.

DAVID VAN ALSTYNE,
Superintendent Motive Power.

Santa Fe Coast Lines.
Motive Power Department.

My first experience with the all-metal car was on the Norfolk & Southern Railroad where we had a lot of iron pipe cars, leased from the Southern Car Company, and which, under the conditions then existing on that railroad, where we had very small grades and light engines (not over 18-in. cylinders), the cars gave splendid service compared with the wooden cars, which gave us a great deal of trouble by rotting, and which, in consequence, we were always rebuilding or putting in two or three new sills with the ensuing large expense. The first thing we noticed was that the iron pipe cars were very seldom in the shop for repairs, in fact, hardly ever there unless they had got into a wreck. We then began to inquire whether they were not less expensive for maintenance and repair than the wooden cars, and tried to find out by keeping the exact cost of repairing these cars and a series of wooden cars of about the same age, and found, if I remember rightly, the wooden cars cost eight times as much to keep in repair. As soon as we were satisfied on this point we started to design cars made of commercial shapes and which could be more easily put together and easier to maintain than the pipe cars, which required a large number of special parts for repairs. We tried to make a design as simple as possible, and, in fact, the body of the car was nothing further than commercial shapes cut to length and fastened together, and the usual truss rods applied underneath the car. These cars were fully described in a paper read before the New York Railroad Club about ten years ago. The figures given in the paper showing comparative cost of repairs between the wooden and metal cars were, I think, a great surprise and, I believe, the first figures made public giving this information. The pipe cars referred to were 40,000 capacity, if I remember correctly, while the new cars designed by the Norfolk & Southern were 60,000 lbs. The first of the Norfolk & Southern cars were built about 1892, and I know that during the next six or seven years, while I was with the road, this car was positively as good as new. It had been kept painted, was well able to carry its load and had not got into any wreck, so that every time the car was repainted it was impossible for anyone to distinguish, by examination, whether the metal frame was a

new or old one. It was this main fact which encouraged us to build some more steel cars, and some were built by the Baltimore Car Works about 1896, all of which gave splendid service, and, I believe, are still giving perfect satisfaction. About a year ago, however, I heard that the first car built had just been in a bad wreck, but whether it was totally destroyed or not I cannot say.

These cars were designed with capacity equal to the largest cars made in those days and which were, and still are, enough for the traffic which exists in that part of the country. The great developments in design and capacity made by Mr. Schoen and his associates in the Pressed Steel Car Company were not thought of, and the step taken by them was, of course, a most important one in the development of the steel car question, and was, I presume, brought about by the opportunity presented in hauling ore to the furnaces.

While designing the cars for the Norfolk & Southern Railroad I learned that the making of steel cars for freight service was a common practice in Germany and some of the other European countries, and that they were so successful that the officers of the roads would not think of returning to the use of wood, and I hold strongly to the opinion that all railroad companies should use steel underframes instead of wooden ones, and I believe that while the first cost is greater, the yearly cost of maintenance and renewals would be very much decreased while the life of the car would be prolonged to an indefinite period, only provided that the metal is kept constantly and properly covered with paint.

G. R. Joughins,
Mechanical Superintendent.

Norfolk & Southern Railroad Company.

The six flat cars designed by Mr. Joughins, and built under his personal supervision, have given excellent service and are still doing so. Some cars of similar design that were afterward built by contract have not been so satisfactory, due to lack of due care in construction and the use of light material. Turned bolts were used by Mr. Joughins in the construction of his cars, and great care taken in fitting the parts together properly, and the wisdom of so doing is shown by their present condition, the six original cars being now in practically perfect condition while the contract cars are giving more or less trouble. The cost of repairs has been principally for painting and decking. The cars have been used for hauling pine logs almost exclusively, and the decking being of pine 1¼ in. thick, and the space between the side and intermediate sill unusually wide, have necessitated frequent renewal of broken decking. I think the decking should have been oak 3 in. thick. The average cost of the six cars built by this company, for the five years ending January 31, 1903, has been $9.25 per car per year, including cost of journal bearings, repairs to air brakes and couplers, decking, painting, etc. The amount expended on the steel car proper has been very small indeed.

John Whitestone,
Acting Superintendent Motive Power.

Central Railroad Company of New Jersey.
Office Superintendent Motive Power.

We received 1,000 steel hopper cars of the pressed steel type in April, 1901. These have cost us since for repairs about $10.60 per car annually, distributed as follows:

Details.	1901.	1902.	1903.	Total.
Bodies exclusive of body bolsters	$129.66	$2.473.97	$100.74	$2,704.37
Body bolsters	....	15.01	......	15.01
Sills	....	74.39	22.82	97.21
Draft rigging, exclusive of couplers	....	1.22	......	1.22
Couplers and knuckles	202.83	837.04	588.74	1,628.61
Hoppers and attachments	12.88	137.46	32.50	182.84
Brake, piping and attachments	2.686.53	1,718.97	230.28	4,635.78
Trucks, exclusive of wheels, axles and truck bolsters	1,235.96	520.82	247.75	2,004.53
Wheels and axles	306.41	496.11	279.63	1,082.15
Truck bolsters	384.27	10.08	......	394.35
Journal bearings and keys	180.37	284.40	16.33	481.10
Hand holds and steps	6.04	18.57	......	24.61

This includes a lot of painting. Cars properly painted at the car works should not require paint of any kind before two years of service. Regardless of the cost of suitable wood for car construction, the steel underframing finds favor on account of the additional strength given per pound of dead weight, which is considerable. We are so confident of this that our orders for cars this season embracing steel underframing amount to 2,600. We feel that the time has arrived when only steel shapes of commercial form should be considered for this purpose. The figures we give you do not include the cost of repairs caused by accident, such as collisions or derailments. These cars required a large amount of rather expensive replacements which made the cost of maintenance abnormally high, in addition to the painting.

These cars at the present time are standing up nicely on their centers, and are giving no trouble on account of cut flanges. We feel convinced that the time has arrived to employ steel for underframing on all kinds of cars in place of wood. Our preference is largely in favor of structural steel for frames, and we have only used this form in the frames now building for this company. Our experience leads us to believe that repairs can be made at much less expense where structural steel is employed than where the pressed forms are used, and that there will be much less trouble in securing the material for repairs than where special forms are employed.

W. McIntosh,
Superintendent Motive Power.

Norfolk & Western Railway.
Office of Superintendent Motive Power.

I take pleasure in enclosing you copies of letters from Mr. Friese, general foreman, car department, under date of April 1 and November 11, 1902, submitting all of the information which he has been able to collect. You understand, however, that we have not provided any facilities for the repairs of these cars, and the work is being done by ordinary car repairers, with the same tools which we had prior to the adoption of the steel framed cars, which does not therefore represent what may be accomplished if special tools and facilities were provided for doing this work. It is, however, interesting, inasmuch as it represents in a general way the fact that these cars may be maintained with the same class of labor which we employed when only the wooden car was used. In fact, it is my opinion less skilled labor is required, as it only requires one man in charge to do laying-out work and the straightening of parts, riveting, etc., may be done with ordinary laboring forces. We have lately recommended the erection of a structural shop for the manufacture and repairs of this class of equipment provided with punches, shears, furnaces, clamps, traveling cranes, pneumatic machinery, etc., where this work can be prosecuted to better advantage than at the present time.

W. H. Lewis,
Superintendent Motive Power.

Norfolk & Western Railway Company.

Mr. W. H. Lewis, November 11, 1902.
Superintendent Motive Power.

Up to April 1st of this year we had not gone into keeping accurate record so extensively of this work and we then predicted that the cost of repairs on these cars would range from $175 for badly wrecked cars down to $20 for those slightly damaged. Since that time we have kept records of the cost of this work on a large number of cars and find the above-mentioned figures do not vary greatly from the ones now obtained, in which we find the lowest cost to be $20.36 and the highest $183.48. We did not find any material difference in repairing the class "HF" and class "HG" hoppers, although the class "HF" cars do not have steel side frames, they do have 15-in. side sills and bolsters more complicated and costing for repairs more than the same parts of class "HG" hoppers. We have classified the repairs as follows:

No. 1.—Repairs will include the entire cutting apart of the frame, straightening and re-riveting it, with complete or nearly complete renewal of woodwork, repainting and re-stencilling.

No. 2.—Repairs, cutting apart entire framework, straightening and re-riveting it, with partial renewal of woodwork, repainting and re-stencilling.

No. 3.—Repairs, to include cutting apart, straightening and re-riveting one-half (more or less) of the framework, with renewal of one-half (more or less) of the woodwork, with painting or partial repainting of car.

No. 4.—Repairs will include such cars on which the bent or damaged part of the frame may be straightened and re-riveted without removal. With renewal of rods, rivets, bolts and woodwork that would ordinarily follow slight damage, with partial repainting and stencilling.

Cost of Work Under Above Classification.

No. 1.—Repairs, average, labor $100.23, material $34.55, total $134.78.

No. 2.—Repairs, labor, $77.89, materials $30.46, total $108.35.

No. 3.—Repairs, labor $36.48, material $11.02, total $47.50.

No. 4.—Repairs, average, labor $15.79, material $9.94, total $25.74.

For No. 1—Repairs, labor 74 per cent., material 26 per cent.

For No. 2—Repairs, labor 73 per cent., material 27 per cent.

For No. 3—Repairs, labor 76 per cent., material 24 per cent.

For No. 4—Repairs, labor 61 per cent., material 39 per cent.

For all classes of repairs—Labor 82%, material 18%.

All of the above figures for labor point to the necessity for the erection of a building in which to house necessary tools and equipment to cheapen cost of such repairs. With the large additions now being made to our steel car equipment the present facilities are totally inadequate, irrespective of the additional expense necessary on account of not having proper means to handle this work.

N. L. Friese,
General Foreman.

The Christenson Engineering Company, Milwaukee, Wis., state that increased business in Christenson air-brakes and "Ceco" electrical machinery requires a change in their organization which will place their business in the hands of a newly organized concern—the National Electric Company—with purposes, ownership and management the same as before.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

By R. V. Wright, Mechanical Engineer.

III.

Upon undertaking the drawing up of designs for adapting the individual motor drive to the engine lathes it was decided to use, as far as possible, the arrangement of gearing described in the previous article of this series (pages 165-168 of the May, 1903, issue). Because of the construction of the headstocks of some of the lathes, however, it was found necessary to modify this in a few cases.

On an old type of 25-in. Putnam lathe it was found necessary to arrange the gearing as shown in Fig. 9. The silent chain sprocket, B, and the gear, C, are keyed to an extension hub on the right-hand clutch. Gears H and F run loose on the main spindle, the drive to the back shaft and the other connections being similar in principle to those in the motor drive previously illustrated on page 167.

As shown in Fig. 10 this throws the motor nearer the middle of the headstock than in the arrangement shown in Fig. 4, page 166. It also does away with the special clutch handle bracket shown to the right of the motor bracket in Fig. 7 (page 167); in this case the bracket which supports the motor carries both the clutch handles, as shown in Fig. 10.

Another interesting case is that of a 42-in. Niles triple geared engine lathe (Fig. 12), which required very little changing, only one run of gears and a clutch being added. In this case the belt cone is simply removed and replaced, as indicated in Fig. 11, by a sleeve, which carries, in addition to the pinion 1 and the regular latch plate, a new gear, 3, and the silent chain sprocket, 10. On the back shaft are added a double clutch and a new gear, 4. Gears 1, 2, 5, 6, 7 and 8, are the original ones, while gears 3 and 4 and chain spockets 9 and 10 are new. Gear 2 (Fig. 11) in place of being keyed to the back shaft, runs loose upon it, and the jaw clutch mounted upon it simply fits over the hub of the gear and is keyed to it, as indicated in the detail view at the left of Fig. 12. This special sleeve clutch is shown in detail in Fig. 13.

Upon this type of triple geared lathe the pinion, indicated at 7, on the end of the back shaft, is arranged for meshing with an inside gear at the rear of the face plate; when it is thrown over into mesh, gear 5 is carried along the back shaft with it and out of mesh with gear 6.

With the set of new gears which have been added we will

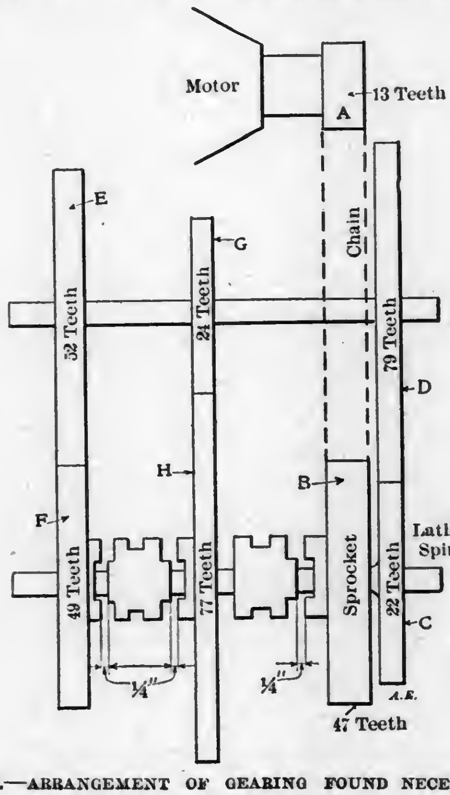


Fig. 9.—Arrangement of Gearing Found Necessary on a 25-in. Putnam Lathe.

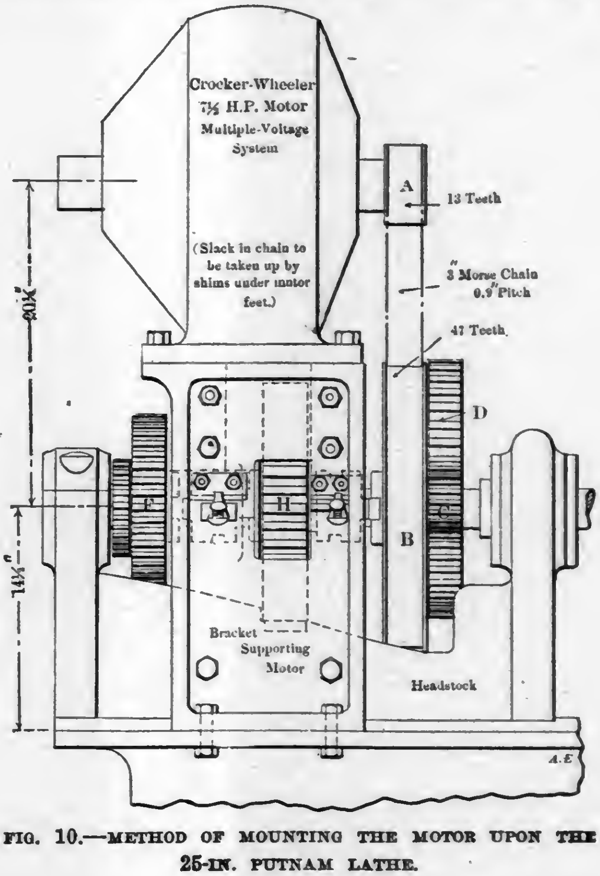


Fig. 10.—Method of Mounting the Motor Upon the 25-in. Putnam Lathe.

have five runs of gearing, or five different speeds, for each motor speed. These reductions will be as follows:

First: $\frac{16}{70}$ (direct, through latch plate);

Second: $\frac{16}{70} \times \frac{52}{119} \times \frac{47}{100}$;

Third: $\frac{16}{70} \times \frac{31}{140} \times \frac{47}{100}$;

Fourth: $\frac{16}{70} \times \frac{52}{119} \times \frac{15}{92}$; and

Fifth: $\frac{16}{70} \times \frac{31}{140} \times \frac{15}{92}$.

The various runs overlap each other, in some cases, but they cover the desired range of speed very nicely.

The lathe spindle speeds, in revolutions per minute, run thus:

	40 volts.	5.7 h.p. 80 volts.	10.3 h.p. 160 volts.	Maximum.
First run	..	55	120	241
Second run	..	..	24.8	49.5
Third run	..	..	12.5	25
Fourth run	..	..	8.6	17
Fifth run	.8	2	4.3	8.7

On this lathe the higher run will not be used much and full power will not be required at these speeds.

In applying the motor, used in this case, the original main spindle and back shaft journal-bearing caps are removed and the cast-iron brackets which carry the angle-iron support for the motor, as shown in Fig. 12, are fitted in their places. The top of the main spindle journal brass is flat, which permits the bracket to be very readily fitted. The bracket required for this support is, of course, of a special design, as is indicated in the detail drawing of it presented in Fig. 14. It will be noted from Fig. 12 that these two special brackets take care of the end bracing also, inasmuch as they are merely tied together at the top by angle bars.

In closing the discussion on the application of the individual motor drive to engine lathes which were originally designed for the belt drive, it might be said, and this refers particularly to the smaller size lathes, that more difficulties had to be overcome in drawing up the designs for changing them than for any other one type of machine tool.

In several cases the design of the headstock was such that it was impossible to put a large enough silent chain sprocket on the main spindle, and the maximum spindle speed, and therefore the speed range, necessarily had to be greater than was actually required. This was not so serious in itself, but

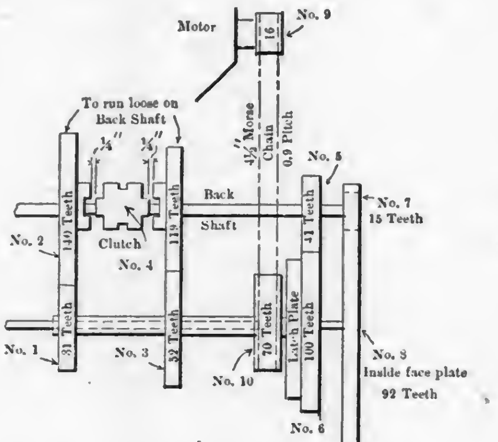


FIG. 11.—ARRANGEMENT OF GEARING UPON A 42-IN. NILES TRIPLE-GEARED LATHE.

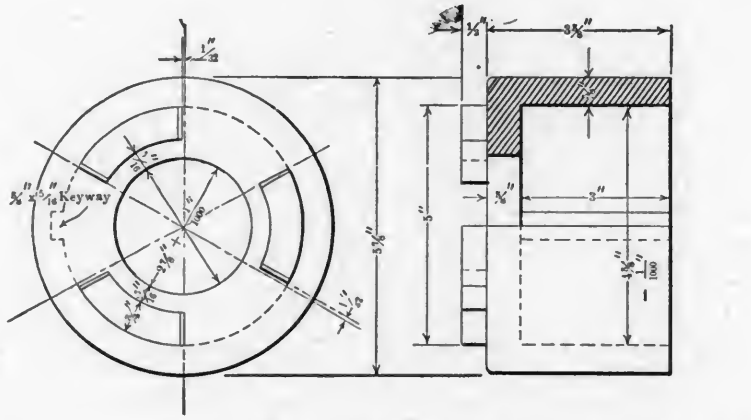


FIG. 13.—SPECIAL SLEEVE CLUTCH KEYED TO THE HUB OF GEAR NO. 2 OF THE 42-IN. NILES LATHE.

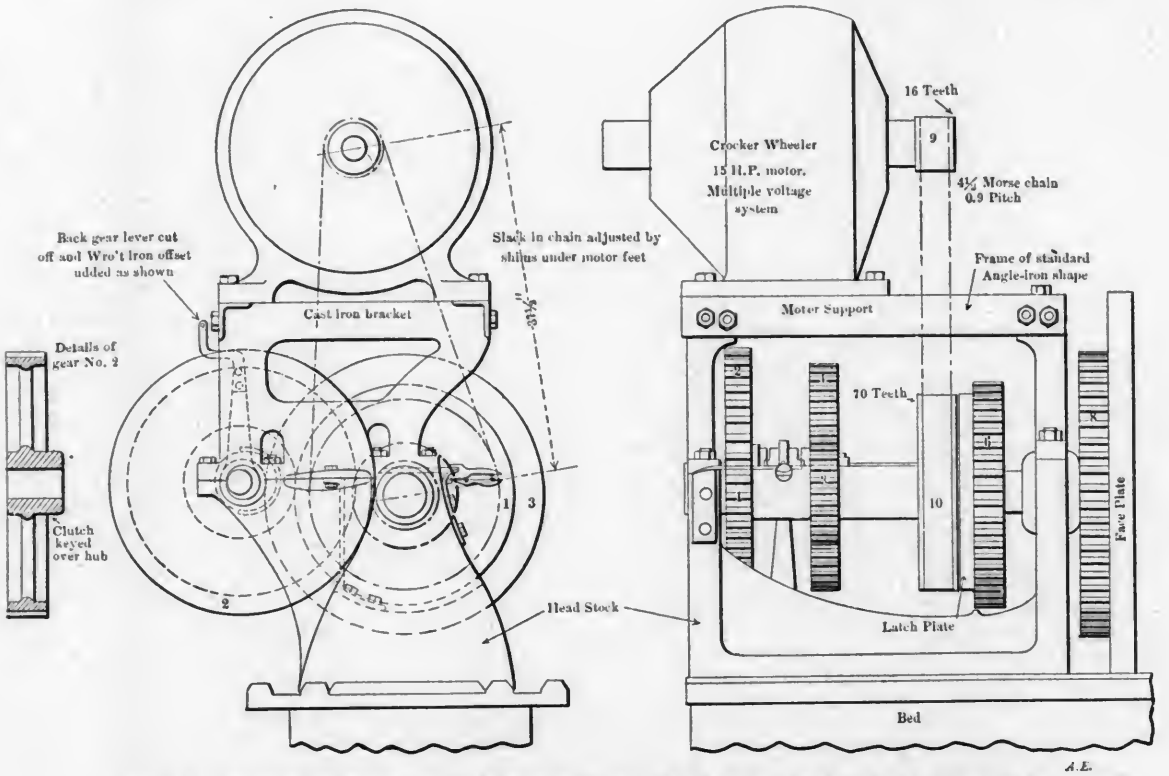


FIG. 12.—METHOD OF MOUNTING THE MOTOR UPON THE 42-IN. NILES TRIPLE-GEARED LATHE.

as a result it was difficult to get the minimum spindle speed desired; this was on account of the fact that a greater reduction had to be made on the two runs of gearing, and that the sizes of the main and back shafts were such that we had to make the cross-section of the metal through the rim of the small pinion, where it was keyed to the shaft, a minimum in order to get the number of teeth small enough for the proper reduction.

In a large machine shop a lathe can, in many cases, be assigned to a particular class of work and, if necessary, the speed range can be more limited than if it was to be used in general work. In one case it was found that the proposed range of speed could not be obtained on account of the construction of the lathe, and it was determined to assign that lathe to a par-

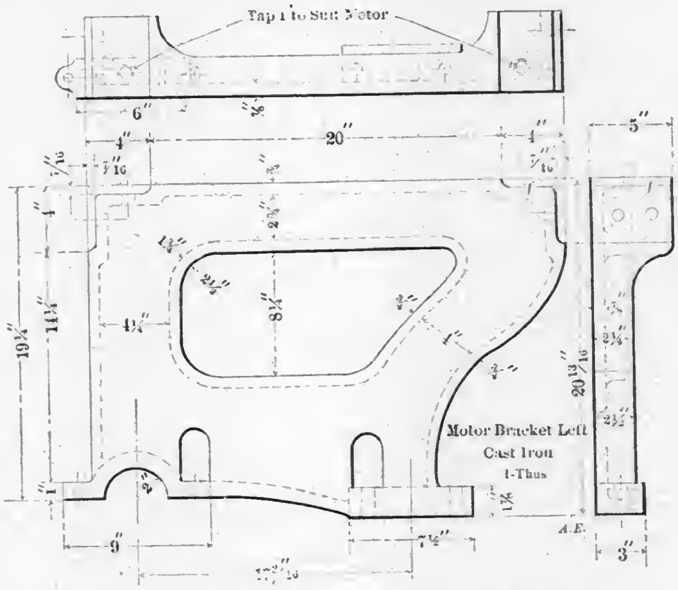


FIG. 14.—DETAILS OF THE SPECIAL BRACKET DESIGNED FOR SUPPORTING THE MOTOR ON THE 42-IN. NILES LATHE.

ticular class of work, the limiting diameters of which were such that the speed limits could be so changed that we could easily arrange for the application of the motor.

In this case the cone will simply be removed and replaced by a sleeve, which will carry a silent chain sprocket and the pinion. The back gear ratio will be properly reduced. The back gear will be thrown in and out in the same manner as before. This is, however, the only case out of the eight lathes to be equipped in which such a radical compromise had to be made.

The limiting sizes of work to be handled on a car axle lathe are such that the motor itself can easily take care of the range of speed required.

The size of work would range from 3¾ ins. in diameter, or a little less, for worn journals for 40,000 lbs. capacity cars to 7¾ ins., or a little more, the diameter over the rough collar of the axle for a 100,000-lb. capacity car.

Now a cutting speed of 50 ft. per minute over this range of

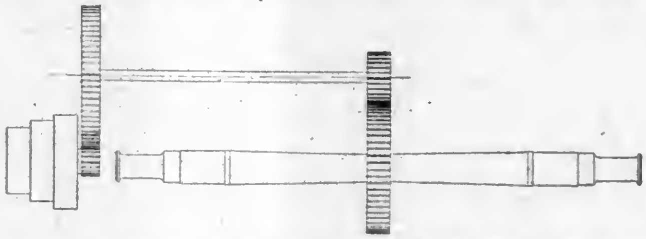


FIG. 15.—ORIGINAL ARRANGEMENT OF GEARING IN THE DRIVE OF A CAR-AXLE LATHE.

diameter would require from 26 to 52 revolutions per minute of the work, or a speed range of 2 to 1. (See Fig. 3, page 166, of the preceding issue.) The material to be cut is soft steel and the constant that should be used in the horse-power formulæ determining the power required to take the cut (see on page 125 of the April, 1903, issue) would probably be about 0.6. For

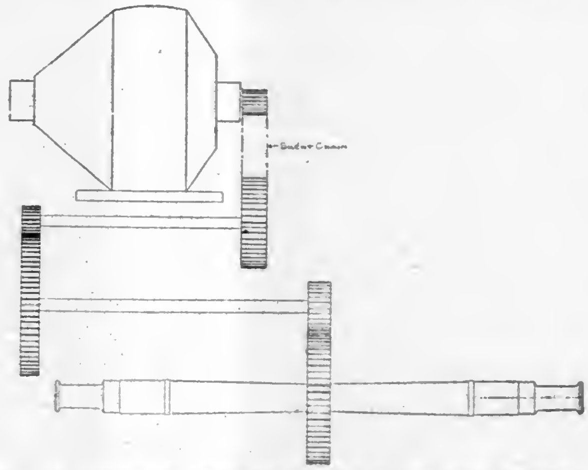


FIG. 16.—DIAGRAM SHOWING CHANGE IN THE DRIVING GEARING OF THE CAR-AXLE LATHE TO ACCOMMODATE MOTOR DRIVE.

a cut 5/16 in. deep taken with 3/32 in. feed the horse-power equals $\frac{3}{32} \times \frac{5}{16} \times 50 \times 12 \times 2 \times .6 = 21$.

By reference to the diagram in Fig. 1 on page 165 of the pre-

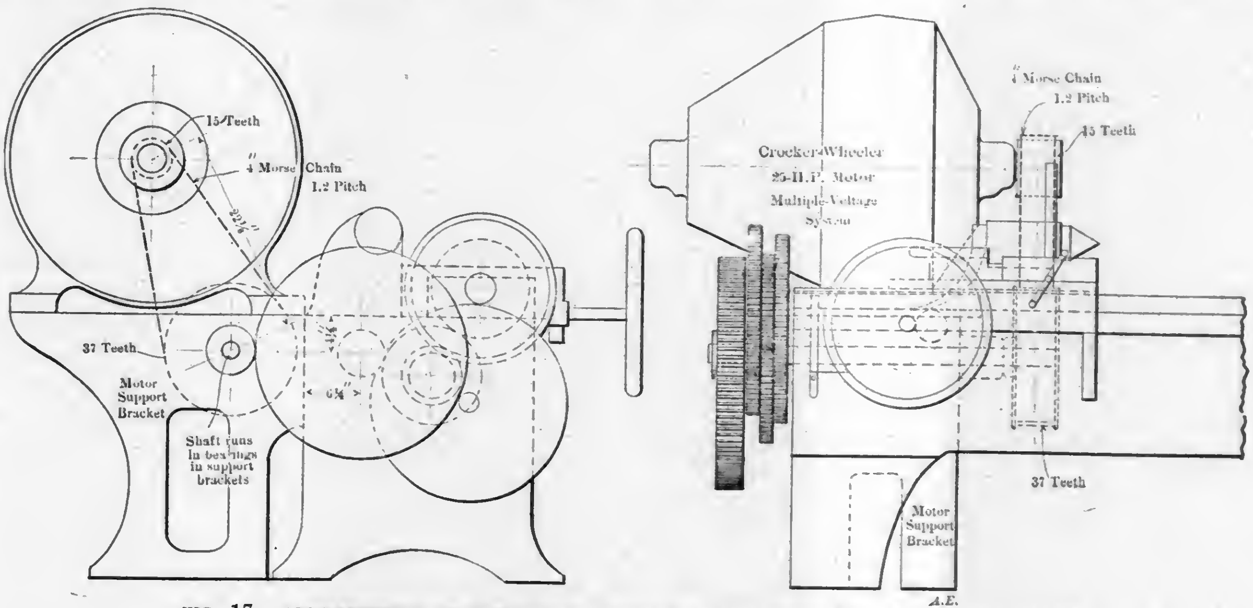


FIG. 17.—ARRANGEMENT OF THE MOTOR SUPPORT BRACKET UPON THE CAR-AXLE LATHE.

ceding issue, it may be seen that the motor, when running at half speed, is exerting 76 per cent. of its rated power. If, at 76 per cent. of full power, 21 h.p. is to be exerted, it may readily be seen that the full power should be about 27.5 h.p. Therefore the tool will require about a 25-h.p. motor.

Fig. 15 shows the arrangement of gearing which was originally applied to the belt-driven axle lathe which we are now about to change to be motor driven. The cone and small pinion are one piece and run on a stud. These will be entirely removed and the motor will be connected as shown in Fig. 16.

The lathe bed is so constructed that the motor could not very well be placed above it and a bracket was designed to fit to the back of the lathe and carry the motor as shown in Fig. 17. The bracket which carries the motor is designed and fitted with bronze bushings to carry the countershaft which has on one end the silent chain sprocket and on the other end the small pinion. The bracket is so near the end of the lathe that it will not interfere with the crane hoist which handles the axles.

(Note:—We are informed by Mr. Wright that in the diagram presented in Fig. 1, page 165 of our May, 1903, issue, the notation in the upper left-hand corner should read "large" and "small" circles, instead of "heavy" and "light." Also in the engraving, Fig. 7, on page 167, handle A should be marked B, and vice versa. We regret these errors.—Ed.)

POWER TEST OF GROUP DRIVE MOTORS.

RECORDS OF POWER REQUIRED FOR THE GROUP DRIVES AT THE ROANOKE SHOPS.

NORFOLK & WESTERN RAILWAY.

Through the courtesy of Mr. W. H. Lewis, superintendent of motive power, we are enabled to present the following records of an elaborate series of tests recently made at the Roanoke shops to determine the power required by the various group drive motors for machine driving. As will be recalled, the Roanoke shops were equipped for electric driving about a year ago, the two-wire, 220-volt direct-current distribution system being used and the machines being driven in groups by constant-speed motors to the exclusion of individual driving. An account of this installation was presented by Mr. C. A. Seley in a paper before the 1902 convention of the Master Mechanics' Association. (See abstract on page 230 of our July, 1902, issue.)

Graphical records are presented of tests made upon fifteen of the group-drive motors. The machines connected in each group are given in the accompanying tool list. The following is quoted from the report of Mr. Quinn, electrician at the shops:

"Herewith are attached graphical results of the motor tests made at the Roanoke shop. These data are from consecutive readings taken during a five hour test and show the performance of the motors during the heaviest load that we would expect to occur during the day. Each test record shows the power consumed with the motor running light, the power consumed with the motor and shafting running light, and the power required for the motor, shafting and machines, all together.

"By taking the readings from the middle of tests, we were sure that the motors were thoroughly heated and the internal losses were at a maximum, and results show what could be expected in every-day practice, and not results from short, intermittent tests of a few minutes with machines operating for the special benefit of the test to be made. No special effort was made to load up machines, or in any way deviate from the every-day practice in operation of the machines in the shop, as the results desired are for future reference, and are to give a broad idea of what might be expected from motors of different sizes when used for group driving, and also to determine to what extent, and for what length of time, we might overload a motor and still expect it to continue in service.

"Some of the results shown are very remarkable, especially that of the test of group No. 9. I believe that these results,

GROUP TOOL LIST.

TESTS OF GROUP MOTORS AT ROANOKE SHOPS.

MACHINE SHOP.

GROUP NO. 1—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 20 H.P.
Minimum power required = 12.6 H.P.
Average power required = 16 H.P.

Machines.	Size.	Makers.
Quartering machine	No. 2	N. Y. Steam Eng. Co.
Lathe	18 ins. x 16 ft.	Schenck.
Emery wheel		
Driving-wheel lathe	80-in. plate	Sellers.
Milling machine	Keyways in axle	Newton.
Pipe cutter		D. Saunderson & Son.
Slotter	12-in. stroke	Niles.
Slotter	16-in. stroke	Niles.
Slotter	6-in. stroke	Newton.
Vertical boring mach.	84 ins. diameter	Niles.
Vertical boring mach.	84 ins. diameter	Niles.
Keyway milling mach.	42 ins. long	Bement & Son.
Cylinder planer	60 x 60 ins.	Sellers.
Lathe	14 ins.	Bement & Son.
Cylinder borer		Niles.
Radial drill press		Niles.
Lathe	16 ins. x 13 ft.	Sellers.
Lathe	14 ins. x 12 ft. 6 ins. extension	Harrington.
Lathe	8 ins. x 7 ft.	Blair.
Hydraulic wheel press		

GROUP NO. 2.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 18.9 H.P.
Minimum power required = 10.6 H.P.
Average power required = 14.4 H.P.

Lathe	8 ins. x 7 ft.	Blair.
Lathe	8 ins. x 7 ft.	Blair.
Lathe	8 ins. x 7 ft.	Blair.
Lathe	8 ins. x 7 ft.	Blair.
Lathe	7 ins. x 7 ft.	Grant & Bogert.
Frame slotter	3 heads	
Lathe	8 ins. x 6 ft., brass	Lodge & Davis.
Lathe	10 ins. x 10 ft.	
Lathe	8 ins.	R. K. LeBlond.
Drill Press	50 ins.	Niles.
Lathe	8 ins.	R. K. LeBlond.
Lathe	Brass	Cooper, Jones & Cabu.
Planer	36 x 36	Sellers.
Lathe	7 ins.	Grant & Bogert.
Lathe	Brass	Cooper, Jones & Cabu.
Lathe	Brass	Springfield Mch. T. Co.
Lathe	Brass	Springfield Mch. T. Co.
Lathe	Brass	Grant & Bogert.
Planer	48 x 48	Sellers.

GROUP NO. 3.—35-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 37.6 H.P.
Minimum power required = 12 H.P.
Average power required = 17 H.P.

Lathe	Brass	Am. Tool Mach. Co.
Lathe	8 ins., brass	Manning, M. & Moore.
Stud lathe		Niles.
Emery wheel		
Lathe	12 ins.	Flather & Co.
Stud lathe		Jones & Lamson.
Stud lathe		Smith & Courtney.
Lathe turret		Niles.
Lathe	8 ins.	Lodge & Davis.
Planer	36 x 36 ins.	Sellers.
Lathe	10 ins.	Flather & Co.
Grinding lathe		Whitworth.
Drill press		
Drill press		
Lathe	8 ins.	Manning, M. & Moore.
Flue rattler		
Hydraulic press	Small, for rod brasses	
Polishing wheel		

GROUP NO. 4.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 19.4 H.P.
Minimum power required = 3.4 H.P.
Average power required = 10.2 H.P.

Gang drill	6-spindle	Bement Miles.
Rod drill		Pond Machine Co.
Rod drill		Niles.
Drill press		

GROUP NO. 5.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 35.4 H.P.
Minimum power required = 6.3 H.P.
Average power required = 14.7 H.P.

Double-head axle lathe		Niles.
Double-head axle lathe		Niles.
Double-head axle lathe		Niles.
Double-head axle lathe		Niles.
Double-head axle lathe		Niles.
Emery wheel		Niles.

GROUP NO. 6.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 28.9 H.P.
Minimum power required = 4.7 H.P.
Average power required = 11.2 H.P.

Wheel grinder		
Wheel borer	Car Wheels	Niles.
Wheel borer	Car Wheels	Niles.
Wheel borer	Car Wheels	Niles.
Wheel borer	Car Wheels	Bement Miles.
Hydraulic press	Car Wheels	Niles.

when the first cost, cost of maintenance and weight of metal removed per dollar invested in driving machinery is considered, will compare favorably with other methods of electrical driving. This is to a certain extent brought about by having the piecework system in use in these shops, which makes the cost of turning out a piece of work a fixed quantity. The variable is therefore found in the cost of driving the machine, and, while this is a very small percentage as compared with the wages of the machinists, still in a shop of this size I believe it will amount to quite an item, especially when the interest on original investment is taken into consideration.

"The majority of machines in this shop are each doing a certain class of work, which calls for very few speed changes, and by having the piecework system in use, we may conclude that each machine is operated at its most economical speed, and that individual driving would thus not increase the output to any marked extent.

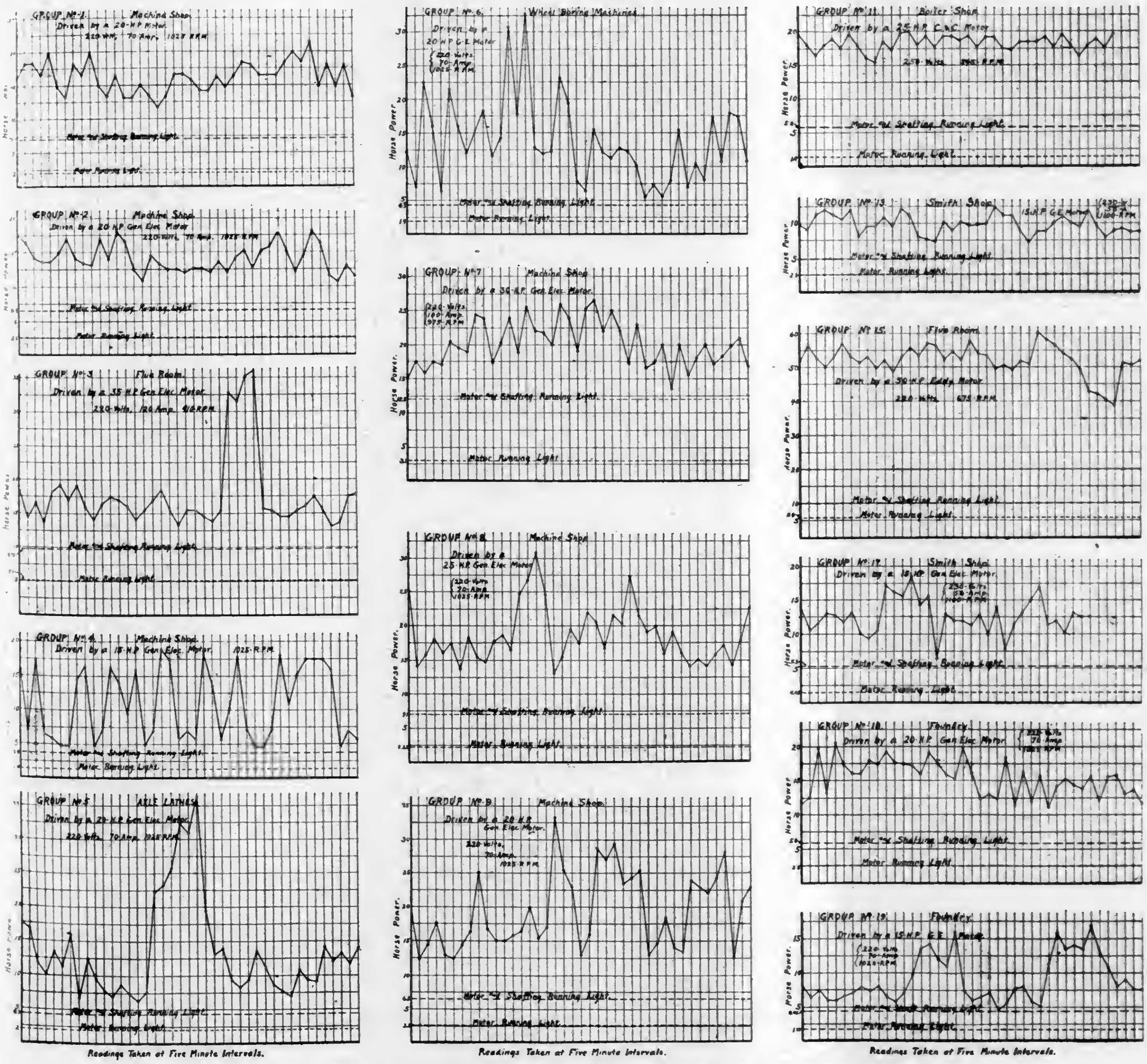
"With the attached sheets you will find the power used by the motor running alone, disconnected, represented by the lowest dotted line, and that for the motor and the line shaft only (with all machines idle) represented by the upper dotted line. From these two lines we can readily see what percentage of power is taken up by shafting and belting,

GROUP NO. 7.—30-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 27.7 H.P.
Minimum power required = 9.2 H.P.
Average power required = 19 H.P.

Hor. D. B. borer		Bement & Son.
Vert. milling machine	36 ins. diameter	Hilles & Jones.
Shaper, double-head	12-in. stroke	Bement & Son.
Vert. D. B. borer		Niles.
Planer	32 x 32 ins.	Niles.
Hor. milling machine		Bement, Miles & Co.
3 grindstones		
1 polishing wheel		
1 emery wheel		
Guide grinder		Kendall & Gentry.
(TOOL ROOM.)		
Lathe	8 ins.	Blair.
Lathe	7 ins.	Grant & Bogert.
Lathe	7 ins., hand feed	
Shaper	8-in. stroke	Bement & Son.
Univ. milling machine.		Brown & Sharpe.
Single milling mach.		Pratt & Whitney.
Planer	16 x 18 x 30 ins.	Pratt & Whitney.
Hack saw		Millers Falls Co.
Drill press		Harrington & Son.
2 emery wheels (double)		
Twist drill grinder		L. S. Heald & Son.

(Owing to lack of space the remainder of this tool list will appear in the succeeding issue.—ED.)



DIAGRAMS SHOWING VARIATIONS IN POWER DEMANDED BY THE VARIOUS GROUP MOTORS.

POWER TESTS OF GROUP-DRIVE MOTORS——ROANOKE SHOPS, NORFOLK & WESTERN RAILWAY.

and approximately that which goes into the tools driven."

"Test No. 3 is taken from the motor that drives the flue rattler, and the peak represents the load with the rattler on. The smaller machines being easily driven from this shaft, they were kept belted to it, and the installing of an extra motor to drive them thus avoided. From this sheet you may also see approximately the length of time necessary to rattle a certain set of flues.

"Record No. 5 shows a very high peak in the middle of the curve, which is the result of four lathes starting on new axles at the same time. You may notice how the curve dips just before it starts up the peak; this is due to the finishing cuts and polishing of the axles. I might add that this curve represents the most severe test that could be given this motor, and would probably not occur more than once in a week, as it was brought about by changing from one class of axles to another. From the general appearance of the curve (neglecting the peak) we might infer that a 15-h.p. motor would more nearly fit these conditions; but I have tried a 15-h.p. motor and it would not give the desired results. Sparking and heating of the commutator was too frequent to permit it driving this group of machines.

"The 20-h.p. motor for group No. 6 was put in because the fourth boring mill is not in use at all times and the curve shown represents three machines with the wheel presses, and up to the present time this motor has carried the fourth machine without any trouble. The very high load shown by record No. 9 is due to the walking crane, and is of a temporary nature.

"The 25-h.p. motor indicated in record No. 11 is a second-hand machine, already owned by the railway company, and I used it at this point on account of the limited space that I had, and also to get the benefit of the enclosed type of motor, which was very necessary at this point, on account of the surrounding machines, and the shavings flying from them.

"The 15-h.p. motor indicated in record No. 13 shows the effect of external heating, due to the proximity of the bolt furnaces and the piling of heated, newly-made bolts in the neighborhood of the machine. This motor is operating at only approximately two-thirds load, but a 10-h.p. machine would not give satisfactory results if put in its place, owing to this excessive heating. I have omitted record No. 16, as the results from the test on this group was of very little practical use, the group of machines being very small and the work of a varying nature.

"I might add, in conclusion, that these motors have all been loaded so that the best results with regard to good running and maximum load might be obtained—neither being sacrificed for the other. The motors have been running for six months with the loads herewith shown, and nothing has developed that would indicate the necessity of a change in any of the groups. This does not include the installing of new machines, which, in the future, may make it necessary to make additions or changes in some of the groups where this would occur."

We are indebted to Mr. J. A. Pilcher, mechanical engineer of the Norfolk & Western, for these records, the tests having been carried out by Mr. Quinn, electrician of the Roanoke shops.

THE PROPORTIONS OF MODERN LOCOMOTIVES.

LAWFORD H. FRY.

The accompanying tables show the results of an investigation of the main proportions of over two hundred modern locomotives of all classes. This analysis was carried out with the idea of studying the proportions given to modern locomotives by their designers. By collecting a sufficient number of examples and properly grouping and averaging them figures have been obtained which give definite information regarding current American practice. The figures on which the present tables are based cover practically all of the important locomotive designs which have been described in the technical papers in the last three years. In nearly every class of engine examined the examples are sufficiently numerous to give average results not largely influenced by any special design. The examination covers those principal ratios, or factors of design, which enable proper comparisons to be made between the fundamental proportions of the various engines, viz.:

Factor of Adhesion.—Measuring the proportion of weight on driving wheels to maximum cylinder tractive effort.

Factor of Steaming Capacity.—Measuring the proportion of cylinder power to boiler power.

Factor of Efficiency of Design.—Measuring the proportion of total weight to heating surface obtained.

Table 1 shows the average values of these factors as determined for the locomotives of each type and class. The engines in many of the classes have been subdivided into groups, according to their weight, and the average factors determined for each group, so as to show the influence of the weight of the engines on the value of the factors. The results of this show several points in favor of the heavy engines.

In column 1, of table 1, is given the type of the locomotive and in column 2 is given the class. By "type" is to be understood the wheel arrangement, as Atlantic-type, American-type, etc., and by "class" is to be understood the style of cylinders, whether single expansion, or two, or four-cylinder compound. The tandem and Vauclain compounds have not been separated, as the difference between these does not affect any fundamental principal of design. In column 3 are given the limits of weight between which the locomotives in each group are contained. The aim has been to give each group a range of 10,000 lbs., but the grouping is of course dependent on the number and weight of the locomotives in each class, and in several cases the number of engines in the class has not been sufficient to justify a subdivision. Column 4 gives the number of locomotives in each group. In addition to taking the average of the factors for each group, averages have been struck for each class as a whole, and these figures are given in heavy type below the figures for the groups. The last four columns contain the factors forming the chief object of the investigation.

Column 5, Weight on drivers ÷ tractive effort.

Column 6, Tractive effort ÷ heating surface.

Column 7, Tractive effort × driving wheel diameter ÷ heating surface.

Column 8, Total weight ÷ heating surface.

For reference and comparison the average values of the factors have been collected into separate tables for each factor.

Factor of Adhesion. Table 2.—In this table the average factors from column 5, table 1, are collected according to type and class. It will be seen that the single expansion factors are arranged in ascending order of value. The way in which the types arrange themselves is interesting. The standard types take the following order:

Consolidation, 4.03; American, 4.17; Atlantic, 4.33; Mogul, 4.50; Ten-wheeler, 4.66.

The majority of these are lower than are recommended by the Master Mechanics' Association, and it would seem that the Consolidation and American-type engines are designed to utilize their full adhesion when running with less than full stroke cut-off. The position of the Moguls appears to need some explanation, as there is no obvious reason why they should not have practically the same factor as the Consolidations. An explanation of the value of the factor for the Ten-wheelers is obtained by considering them as American-type engines with an additional pair of driving wheels. The limit of weight with two pairs of drivers having been reached, a further increase in weight requires a third pair of drivers, and, in adding these, more weight is added than is required for the increase in tractive power. In other words, in changing from the American to the Ten-wheeled type, structural considerations render it necessary to make the increase in weight on driving wheels proportionately greater than the increase in cylinder tractive effort. A similar consideration of the Prairie-type as an enlarged Atlantic-type explains the high factor of adhesion of the Prairie-type.

It will be noticed that the four-cylinder compounds show approximately 10 per cent. higher factors than the single expansion engines of the same class. This is of course due to the fact that the compounds are designed to work with a longer cut-off, and on starting they can, by admitting live steam to the low pressure cylinders, develop for a short time a greater tractive effort than that counted on in the tables. In calculating the tractive effort for the tables the mean effective pressure has been taken at 85 per cent. of the boiler pressure for the single expansion engines. For the four-cylinder compounds the high pressure mean effective is taken as two-thirds and the low pressure as one-quarter of the boiler pressure. For the two-cylinder compounds the work is assumed to be equally divided in the two cylinders, the mean effective in the high-pressure cylinder being taken as two-thirds the boiler pressure.

Factor of Steaming Capacity. Table 3.—This table contains the average values from column 7 of table 1. The value of the ratio given in column 6 (tractive effort to heating surface) is obviously, for any given locomotive, a measure of the proportion of the cylinder power to the boiler power, but as the tractive effort is inversely proportional to the driving-wheel diameter, the ratio is dependent on the driving-wheel diameter and is therefore not generally suitable for comparing the steaming capacities of locomotives. By multiplying by the driving wheel diameter one obtains the factor given in column 7, table 1, which is free from this objection and which can be shown by theoretical considerations to be a proper measure of the steaming capacity of any locomotive. (See AMERICAN ENGINEER, October, 1902, and February, 1903.) It is found, theoretically, that for high speed service the steaming capacity factor should have a low value and that a high value factor indicates that the engine is suitable for slow speed service. This is well confirmed by the figures obtained from actual practice and given in table 3. This table gives a practical value to the steaming capacity factor, for it puts one in the position of being able to say at once for any engine how the relation between heating surface and cylinders stands in regard to current practice.

Factor of Efficiency of Design.—The collected results from column 8, of table 1, are shown in table 4. The average weight per square foot of heating surface is given for each class and then the figures for all the classes of each type are averaged together. It will be seen that the high speed types are the lightest per unit of heating surface and that there is a gradual increase in weight towards the slower freight engines. This factor shows the economy or otherwise with which the designer has arranged his material and deserves considerable attention. Any unnecessary weight has to be paid for in the first instance and has ever afterwards to be hauled about as dead weight, and it is therefore obviously desirable to keep the total weight as low as is consistent with strength and satisfactory design. The average figures do not show any marked variations, but the individual figures from which the tables are compiled show a wide range of weights per unit of heating surface, going from 49.4 lbs. per square foot of heating surface up to over 80 lbs. per square foot.

TABLE 1. AVERAGE VALUES OF FACTORS OF COMPARISON.

Type.	Class.	Weight Limits.	Number of locomotives.	Weight on drivers / Tractive effort	Tractive effort / Heating surface	Tract. eff. × driv. dia. / Heating surface	Total weight / Heating surface
Pacific (4-6-2)	Sing. exp..	**219,000–173,000**	**4**	**4.39**	**8.61**	**622**	**55.9**
Prairie (2-6-2)	do	**203,600–140.000**	**7**	**4.94**	**8.56**	**584**	**58.0**
do	4-cyl. comp.	**209,900–176,000**	**4**	**4.61**	**8.94**	**609**	**58.0**
Atlantic (4-4-2)	Sing. exp..	191,000—180,000	3	4.11	7.65	631	62.4
do	do	180,000—170,000	6	3.91	7.99	619	56.5
do	do	170,000—160,000	3	4.01	8.38	646	59.1
do	do	160,000—150,000	6	4.11	8.36	635	61.3
do	do	141.000—136,200	4	4.47	9.17	689	64.2
do	do	**191,000–136 200**	**22**	**4.33**	**8.31**	**641**	**60.4**
do	4-cyl. comp.	183,000—180,000	2	4.79	6.63	557	58.9
do	do	180,000—160,000	4	5.18	6.54	551	64.3
do	do	150,000—132.700	5	4.34	7.59	590	65.4
do	do	**183,100–132,700**	**11**	**4.73**	**7.03**	**561**	**63.8**
American (4-4-0)	Sing. exp..	**146,400–104,800**	**11**	**4.17**	**9.99**	**707**	**63.0**
Ten-wheel (4-6-0)	do	179,000—170,000	7	4.94	9.46	716	63.8
do	do	170,000—160,000	5	4.64	11.27	762	67.6
do	do	160,000—150,000	11	4.47	11.47	748	65.9
do	do	150.000—128.200	7	4.64	10.91	760	66.6
do	do	**179 000–128 200**	**30**	**4.66**	**10.94**	**746**	**65.8**
do	4-cyl. comp.	191,800—180,000	5	4.92	9.90	692	65.6
do	do	180,000—170,000	4	4.90	9.79	652	64.3
do	do	160.000—138.700	4	5.11	9.57	684	66.2
do	do	**191 800–138 700**	**13**	**4 97**	**9.76**	**678**	**65.3**
do	2-cyl. comp.	175,500—150,000	5	4.68	10.05	670	63.5
do	do	141,000—105.000	4	4.73	12.11	724	74.1
do	do	**175,500–105,000**	**9**	**4.70**	**10.97**	**694**	**68.2**
Conslidtn. (2-8-0)	Sing. exp..	250.300—200,000	6	3.98	14.57	827	63.6
do	do	200,000—190,000	5	3.91	14.91	792	63.6
do	do	190.000—180,000	11	4.20	13.95	781	65.4
do	do	180,000—170.000	7	3.95	14.35	793	63.0
do	do	170,000—160.000	8	3.94	14.91	841	64.9
do	do	160,000—150,000	7	4.05	15.93	868	70.9
do	do	141.900—121.700	3	4.03	15.06	731	68.9
do	do	**250 300–121 700**	**47**	**4.03**	**14.72**	**815**	**65.7**
do	4-cyl. comp.	225,100—200,000	9	4.24	13.01	742	62.2
do	do	200 000—190.000	2	4.25	13.12	790	62.3
do	do	190,000—180,000	8	4.31	14.91	839	73.3
do	do	180,000—135.800	6	4.37	15.22	835	75.1
do	do	225,100—135,800	25	4.30	14.15	798	68.9
do	2-cyl. comp.	**200,000–144,000**	**10**	**4.01**	**14.64**	**829**	**66.4**
Mogul (2-6-0)	Sing. exp..	169.000—160.000	5	4.50	12.54	766	60.5
do	do	155 000—126.000	6	4.49	13.78	858	71.6
do	do	**169,000–126,000**	**11**	**4.50**	**13.21**	**806**	**66.5**
do	4-cyl. comp.	**168,900–135,000**	**3**	**4.71**	**13.09**	**791**	**71.8**
Mastodon	Sing exp..	**221,500–172,000**	**6**	**3.86**	**14.30**	**789**	**68.0**
do	2-cyl comp.	**193,000–182,200**	**5**	**4.02**	**13.99**	**767**	**70.9**

TABLE 2. FACTOR OF ADHESION.

Type.		Single expansion		4-Cylinder compound.		2-Cylinder compound.	
		No. of Locos.	Factor of adhesion.	No. of Locos.	Factor of adhesion.	No. of Locos.	Factor of adhesion.
Mastodon	(4-8-0)......	6	3.86	..	...	5	4.02
Consolidation	(2-8-0)......	47	4.03	25	4.30	10	4.01
American	(4-4-0)......	11	4.17	..	...	..	...
Atlantic	(4-4-2)......	22	4.33	11	4.73	..	...
Pacific	(4-6-2)......	4	4.39	..	...	..	...
Mogul	(2-6-0)......	11	4.50	3	4.71	..	...
Ten-wheel	(4-6-0)......	30	4.66	13	4.97	9	4.70
Prairie	(2-6-2)......	7	4.94	4	4.61	..	...

TABLE 3. FACTOR OF STEAMING CAPACITY.

Type.		Single expansion.		4-Cylinder compound.		2-Cylinder Compound.	
		No. of Locos.	Steaming factor.	No. of Locos.	Steaming factor.	No. of Locos.	Steaming factor.
Prairie	(2-6-2)........	7	584	4	609	..	...
Pacific	(4-6-2)........	4	622	..	...	..	...
Atlantic	(4-4-2)........	22	641	11	561	..	...
American	(4-4-0)........	11	707	..	...	..	...
Ten-wheel	(4-6-0)........	30	746	13	678	9	694
Mastodon	(4-8-0)........	6	789	..	...	5	767
Mogul	(2-8-0)........	11	806	3	791	..	...
Consolidation	(2-8-0)........	47	815	25	798	10	829

TABLE 4. FACTOR OF EFFICIENCY OF DESIGN.

Type of locomotive.		Number of locomotives of each class				Average total weight in lbs. per sq. ft. of heating surface.	
		Single expansion.	4-Cylinder compound.	2-Cylinder compound.	All classes.	Average for class.	Average for type.
Pacific	(4-6-2)......	4	..	..	4	55.9	55.9
Prairie	(2-6-2)......	7	..	..	..	58.0	...
		..	4	..	..	58.0	...
		..	..	..	11	...	58.0
Atlantic	(4-4-2)......	22	..	..	..	60.4	...
		..	11	..	..	63.8	...
		..	..	..	33	...	61.5
American	(4-4-0)......	11	..	..	11	63.0	63.0
		..	13	..	..	65.3	...
Ten-wheel	(4-6-0)......	30	..	..	..	65.8	...
		..	..	9	..	68.2	...
		..	..	..	52	...	66.1
Consolidation	(2-8-0)......	47	..	..	..	65.7	...
		..	25	..	..	68.9	...
		..	..	10	..	66.4	...
		..	..	..	82	...	66.8
Mogul	(2-6-0)......	11	..	..	..	66.5	...
		..	3	..	..	71.8	...
		..	..	..	14	...	67.6
Mastodon	(4-8-0)......	6	..	..	..	68.0	...
		..	..	5	..	70.6	...
		..	..	..	11	...	69.2

"Resorts and Tours, 1903," is the title of the valuable little brochure published by the Boston & Maine Railroad passenger department, Boston. It contains a list of the resorts and hotels reached by the Boston & Maine Railroad and its connections, giving additional information in regard to the hotel rates and accommodations, the round trip summer excursion rates from Boston, Worcester and Springfield, Mass. The book is free and will be mailed upon receipt of address.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

RATIONAL DESIGN OF LOCOMOTIVE BOILERS.

Under this heading Mr. D. Van Alstyne presented in our June number of last year a strong argument for more space for circulation in locomotive boilers. In this issue Mr. John Player, of the Brooks Works of the American Locomotive Company, adds a powerful impetus to the tendency to sacrifice in the amount of heating surface which may be shown on paper in order to increase the effectiveness of the real heating surface, and this comes from a man whose opinion carries the weight of wide experience and who is known as a designer of successful locomotives. In this issue is illustrated the boiler of a locomotive having a 5-in. mud ring and an account of tests appears which seems to conclusively prove that a layer of steam ¾ in. thick does lie against the sheets of fireboxes when working hard. Mr. Player also makes an important suggestion with reference to the delivery of water from injectors. Two large injectors delivering in the line of circulation at the bottom of the boiler and toward the throat could not fail to help out the firebox sheets and tubes, and we believe the delivery should be at the throat itself. The reader is advised to give most careful consideration to the words of Mr. Player.

CARNEGIE'S GIFT TO ENGINEERS.

A gift of a million dollars to the national engineering societies for a building in which to provide a center for engineers is the latest beneficence of Andrew Carnegie. It has been reported that a union of the societies was contemplated, but this is not true and it is not desirable. Great good may be accomplished by bringing together the various organizations representing mechanical, civil, electrical, mining and marine engineering in one well-appointed building wherein they may co-operate, meet and perhaps concentrate their independent libraries, thus forming a rendezvous for many professional men who are engaged upon various kinds of special work with much of common interest. The importance of this association of the societies, from a social standpoint, is very great, and the possibilities of advantage to all from this sensible concentration are so obvious as to lead to the hope that nothing will prevent a complete and broadminded acceptance of this extraordinary opportunity to accomplish that which has long been desired but has seemed to be impossible. The most distinguished patron of engineering could not have done anything wiser or more far-reaching in the interests of this profession.

STEEL FRAME BOX CARS.

Of all types of cars to which steel framing has been applied the box car presents the most difficult problem and one which has generally been met with a compromise rather than a definite, clean-cut solution. The design by Mr. C. A. Seley which is described by him in this issue meets the problem fairly and is therefore worthy of most careful attention. This is not a steel underframe surmounted by a box structure having its own skeleton of steel and merely fastened to the underframe. It is a complete steel structure wherein the side frames of the box form an important element in the structure and do their part in carrying the load. This is a steel-frame box car in fact as well as name. This design is based upon successful cars of similar construction which are now running on the Norfolk & Western, and, as pointed out by the designer, the new plan is an improvement upon the older one. It may be remarked, incidentally, that Mr. Seley seems to have met the car-roof problem by preventing the weaving, or racking, of the upper structure. The writer is of the opinion that a careful examination of Mr. Seley's drawings will lead many to change their minds entirely with respect to the construction of steel-frame cars of this type.

A TABULAR COMPARISON OF NOTA[illegible]LE

ARRANGED WITH [illegible]SPEC

PASS[illegible]GER L

Type—Drivers	4-6-0	4-4-2	4-4-0	4-4-2	4-6-0	4-4-2	4-6-2	2-6-2	4-4-2	4-4-2	4-4-2
Type—Name	10-wheel	Atlantic	Chautauqua Atlantic	Atlantic	10-wheel	Chautauqua Atlantic	Pacific	Prairie	Atlantic	Atlantic	[illegible]tlantic
Name of railroad	Plant System	C. & N. W.	C., R. I. & P	C. R. R. of N. J.	L.S. & M.S.	B. R. & P.	Mo. Pac.	L.S. & M.S.	N. Y. C. & H. R.	Pa. Lines	P. R. R.
Number of road or class	119	D	1301	....	I-1	162	1118	J	I-2,980	E2A	E2
Builder	Baldwin	Schenectady	Brooks	Baldwin	Brooks	American	American	Brooks	Sch'n't'dy	American	P. R.R. Co[illegible]
Simple or compound	4-cyl. bal. Compound	Simple	Simple	Vauclain Compound	Simple	Simple	Simple	Simple	Simple	Simple	Simple
When built	1902	1900	1901	1899	1899	1902	1902	1901	1901	1903	1901
Weight, engine total, lbs	155,000	158,000	162,000	163,510	171,800	173,000	170,000	174,500	176,000	176,600	176,600
Weight, on drivers, lbs	114,000	91,000	87,000	87,865	133,000	99,000	118,000	130,000	94,800	109,000	109,033
Weight, on leading truck, lbs	41,000	33,000	38,000	41,295	38,800	40,000	35,500	21,500	42,600	36,600	36,650
Weight, on trailing truck, lbs	....	34,000	37,000	34,350	....	34,000	31,500	23,000	38,600	31,000	30,917
Weight of tender (loaded), lbs	....	(empty) 43,200	110,000	100,900	112,000	120,000	117,000	124,500	112,000	143,800	90,000
Wheel base, driving, ft. and ins.	14-1	7-0	7-0	7-3	16-6	8-0	12-4	14-0	7-0	7-5	7-5
Wheel base, total, engine, ft. & ins.	28-4	26-9	28-8	26-7	27-4	20-2	30-5	31-10	27-3	30-9½	30-9½
Wheel base, total engine and tender, ft. and ins.	56-0	54-8¾	53-7	53-2	55-2¼	....	55-1⅓	57-3¼	53-0	60-2½	60-1 13-1[illegible]
Driving wheels, diameter, ins.	73	80	78½	84¼	80	72	69	80	79	80	80
Cylinders, diameter, ins.	15 & 25	20	20¼	14 & 24	20	20¼	20	20½	21	20½	20½
Cylinders, stroke, ins.	26	26	26	26	28	26	26	28	26	26	26
Heating surface, firebox, sq. ft.	128	170.7	189.00	136	223	202.3	153	169.3	180	165.7	166
Heating surface, arch tubes, sq. ft.	....	28.27	....	43	....	....	22	20.7	27.1	......	......
Heating surface, tubes, sq. ft.	2,665	2,816.91	2,617.00	2,478	2,694	2,805.6	2,778.5	3,172.0	3,298.1	2,474	2,474
Heating surface, total, sq. ft.	2,793	3,015.88	2,806.00	2,657	2,917	3,007.9	2,953.5	3,362.0	3,505.2	2,639	2,640
Firebox, length, ins.	131	102⅛	108	114	121	108	78	84⅛	96¼	111	111
Firebox, width, ins.	59½	65¼	74	96	41	74	79¼	83¼	75⅜	72	72
Grate area, sq. ft.	27.25	46.27	54	76	36.6	54.4	42.4	48.6	50.3	55.5	55.5
Boiler, smallest diameter of, ins.	67	68⅝	66	64	66	70⅛	64	66.0	72	67	65
Boiler, height of center above rail, ft. and ins.	....	9-1½	9-7¼	9-0⅛	9-2	9-7½	9-6	9-2	9-3	9-1	9-3 5-1[illegible]
Tubes, number & diameter in ins.	341-2	338-2	322-2	318-2	345-2	336-2	256-2¼	285-2¼	396-2	315-2	315-2
Tubes, length, ft. and ins.	15-0	16-0	15-7¾	15-0	15-0¼	16-0¼	18-6½	19-0	16-0	15-1	15-0
Steam pressure, lbs., per sq. in.	200	200	210	200	210	220	200	200	200	205	205
Type of boiler	Vanderbilt	Straight	Wagon top	Wootten	Extended Wagon-top	Straight	Rad. W. T.	Wagon top	Wide box	Belpaire	Straight
Fuel	Soft coal	Soft coal	Soft coal	Fine Ant.	Bitum. coal	Bitum. coal	Bitum. coal	Bitum. coal	Bitum. coal	bitum. Coal	Bit. and Ant.
Reference in American Engineer and Railroad Journal	Mar., 1902 P. 72	Aug., 1900 P. 237	Apr., 1901 P. 101	....	Nov., 1899 P. 343	Jan., 1902 P. 29	Aug., 1902 P. 236	Mar., 1901 P. 69	Feb., 1901 P. 35	April, 1903 P. 131	June, 190[illegible] P. 188

FREIGHT LO

Type—Drivers	2-8-0	4-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	4-8-0	2-8-0
Type—Name	Consol.	Mastodou	Consol.	Consol.	Consol.	Consol.	Consol.	Consol.	Consol.	Mastodon	Consol.
Name of railroad	L. S. & M. S.	So. Pac.	N. Y. C.	P. R. R.	Nor. Pac.	N. Y. C.	C., R. I. & P.	A., T. & S. F.	I. C.	D., L. & W.	Burlington
Number of road or class	B-1	2026	G-2	H-6-A	Y-2	2399	1603	836	639	808	580
Builder	Brooks	Schenectady	Schenectady	P. R. R.	American	American	American	American	Rogers	Brooks.	American
Simple or compound	Simple	2-cylinder Compound	2-cylinder Compound	Simple	Tandem Compound	Tandem Compound	Simple	Tandem Compound	Simple	Simple	Simple
When built	1900	1898	1901	1899	1901	1902	1903	1902	1899	1899	1903
Weight, engine total, lbs	174,000	192,000	192,000	193,500	198,000	200,000	200,500	201,000	203,000	205,000	207,900
Weight, on drivers, lbs	154,000	155,000	166,000	173,900	175,000	172,500	180,000	176,000	184,800	166,000	181,000
Weight, on leading truck, lbs	20,000	37,000	26,000	20,500	23,000	27,500	20,500	25,000	18,200	39,000	26,900
Weight, on trailing truck, lbs	......	......	......	......	......	......	......	......	......	......	......
Weight of tender (loaded), lbs	124,500	empty 39,650	108,500	134,700	empty 47,000	108,000	144,500	empty 46,400	147,600	106,600	120,400
Wheel base, driving, ft. and ins.	17-4	15-6	19-0	16-6½	17-0	17-0	17-0	15-4	16-3	15-0	15-8
Wheel base, total, engine, ft. & ins.	25-6	26-5	25-11	24-9	26-2	26-3	26-0	24-1	24-5	25-9	24-4
Wheel base, total engine and tender, ft. and ins.	55-4¼	53-6½	53-10	58-1½	53-10½	54-3	57-6	......	56-10½	50-4¼	55-2¼
Driving wheels, diameter, ins.	62	55	63	56	63	63	63	57	57	54	57
Cylinders, diameter, ins.	21	23 & 35	23 & 35	22	15 & 28	15 & 28	22	18 & 28	23	21	22
Cylinders, stroke, ins.	30	32	34	28	34	34	30	32	30	32	28
Heating surface, firebox, sq. ft.	199	206.5	155.4	166.5	155.64	155.4	177	178	221	218	195.96
Heating surface, arch tubes, sq. ft.	22.3	......	27.1	......	26.43	27.09	......	......	......	......	26.71
Heating surface, tubes, sq. ft.	2,653.0	2,819.3	3,298.08	2,675.9	3,231.9	3,298.08	3,087	2,787	2,982	2,950	[illegible],605.8
Heating surface, total, sq. ft.	2,874.3	3,025.8	3,480.6	2,842.4	3,414.0	3,480.57	3,264	2,965	3,203	3,168	[illegible],827.57
Firebox, length, ins.	120¼	120	96	107	100 1-16	96	108	101¼	132	123	108
Firebox, width, ins.	40¼	42	75⅜	66	75¼	75	68	71¼	42	97	72¼
Grate area, sq. ft.	33.5	35	50.32	49.1	52.3	50.32	50	50	38.5	82.4	[illegible]4.21
Boiler, smallest diameter of, ins.	68⅝	72	70⅝	69.5	66.5	70⅝	72	68	79¾	83¼	79⅝
Boiler, height of center above rail, ft. and ins.	9-4⅛	......	9-7	9-2	9-5	9-7	9-9	......	9-2	9-2½	9-7
Tubes, number & diameter in ins.	340-2	332-2¼	396-2	373-2	388-2	396-2	383-2	355-2	417-2	410-2	[illegible]2-2
Tubes, length, ft. and ins.	15-0⅛	14-6	16-0	13-8½	16-0	16-0	15-6	15-0	13-8	13-10¼	[illegible]-0
Steam pressure, lbs., per sq. in.	200	200	210	205	210	210	200	210	210	200	[illegible]10
Type of boiler	Wagon top	Extended Wagon top	Wide box	Belpaire	Wide box	Straight	Wagon top	Wagon top	Belpaire	Wido box	Str[illegible]
Fuel	Bitum. Coal	Bitum. coal	Bitum. coal	Bitum. Coal	bitum. Coal	Bitum. Coal	Bitum. coal	Bitum. coal	Bitum. Coal	Ant. coal	Bitum. [illegible]
Reference in American Engineer and Railroad Journal	Feb., 1900 P. 37	Jan., 1899 P. 26	March, 1901 P. 83	June, 1899 P. 177	Sept., 1901 P. 271	April, 1903 P. 127	March, 1903 P. 107	June, 1902 P. 179	Jan., 1900 P. 13	Nov., 1899 P. 365	Feb., 190[illegible] P. 49

NOTE—These figures have been verified by the railroad officials in charge.

EXAMPLES OF RECENT LOCOMOTIVES.

TO TOTAL WEIGHTS.

COMOTIVES.

4-4-2	4-4-2	2-8-0	4-4-0	4-4-2	2-6-2	4-6-2	4-4-2	4-6-0	4-6-2	2-6-2	2-6-2	Special	4-6-2
Atlantic	Atlantic	Consol.	Atlantic	Atlantic	Suburban	Pacific	Chautauq'a Atlantic	10-wheel	Pacific	Prairie	Prairie	Suburban	Pacific
I. C.	C., M. & St. P.	Col. Mid.	C., B. & Q.	A., T. & S. F.	C. R. R. of of N. J.	C. & O.	C. R. R. of of N. J.	L. V.	Nor. Pac.	I. C.	A., T. & S. F.	N. Y. C.	C. & A.
1001	A-2	201	1586	......	200	147	590	10D-17W	284	1000	P-14-A	1410	601
Rogers	Baldwin	Baldwin	Baldwin	Baldwin	Baldwin	American	American	Baldwin	American	Rogers	Baldwin	American	Baldwin
Simple	Vauclain Compound	Vauclain Compound	Vauclain Compound	Balanced Compound	Simple	Simple	Simple	Vauclain Compound	Simple	Simple	Vauclain Compound	Simple	Simple
1902	1901	1901	1902	1903	1902	1902	1901	1900	1903	1902	1901	1902	1903
178,600	181,535	181,700	183,080	187,000	189,900	190,000	191,000	194,758	202,000	210,800	210,800	216,000	219,000
95,710	100,335	158,500	95,880	90,000	129,000	131,000	99,400	141,348	134,000	140,200	143,600	128,000	141,700
39,290	45,100	23,200	47,000	52,000	21,900	32,000	48,000	53,410	39,000	21,200	29,700	......	36,300
43,600	36,100	......	40,200	45,000	39,000	26,000	43,600	......	29,000	40,400	37,500	......	41,500
147,600	120,000	126,900	......	140,000	Side tank	123,400	124,000	96,500	123.400	147,600	112,600	......	155,000
7-3	7-3	15-9	7-3	6-4	14-0	12-8	7-8	13-0	12-0	13-6	13-8	15-0	13-9
27-9	27-11½	24-4	27-8	15-0	31-8	32-8	29-10	25-3½	33-0	30-9	32-2	35-9	32-8
59-6½	57-5½	53-2	56-0	58-3½	31-8	60-0	53-8	52-6⅞	58-4½	62-1½	57-8¾	35-9	62-0
79	84	60	84¼	73	63	72	85	72	69	75	79	63	80
20	15 & 25	17 & 28	15 & 25	15 & 25	18	22	20½	17 & 28	22	20	17 & 28	20	22
28	28	30	26	26	26	28	26	26	26	28	28	24	28
174.7	207	172.2	155.5	190	96.6	182	174	171.71	175.3	201	195	162	202
......	......	......	......	......	43.0	23	......	......	22.9	......	......	......	28
3,017.0	3,008	2,453.7	2,834.5	2,839	1,695.0	3,328.3	2,793.0	2,536.59	3,265.1	3,333	3,543	2,275	3,848.0
3,191.7	3,215	2,625.9	2,990.0	3,029	1,834.6	3,533.3	2,967.0	2,708.3	3,463.3	3,534	3,738	2,437	4,078.0
102	102	120⅛	96⅛	117 15-16	109	90	123	114	90 3-16	102	108	93	108
72	65⅞	42	66⅞	66	72	75	97	89⅞	75⅜	72	71¼	97⅛	72
51	46.76	35	44.25	49.4	54.5	47	82	71.25	47.2	51	53.5	62.1	54
66	66	74	64	66	60	66	68	64	70	68	70	70	70
9-1½	9-5½	......	......	8-9	9-0	9-0	9-8½	9-2	9-2½	9-2	9-4	9-2 1-16	9-5
351-2	350-2	337-2	380-2	273-2¼	249-2	291-2¼	325-2	325-2	301-2¼	335-2	318-2¼	365-2	328-2¼
16-6	16-6	14-0	16-6	18-1	13-0	19-6	16-6¼	15-0	18-6	19-0	19-0	12-0	20-0
200	200	200	210	220	200	200	210	200	200	200	200	200	220
Wagon top	Wagon top	Straight	Extended Wagon top	Wagon top	Straight	Wagon top	Wagon top	Wide box	Straight	Wagon top	Straight	Straight	Straight
Bitum. Coal	Bitum. coal	Bitum. Coal	Bitum. coal	Bitum. Coal	Ant. coal	Bitum. Coal	Ant. coal	Ant. coal	Bitum. Coal	Bitum. coal	Bitum. coal	Ant. coal	Bitum. Coal
......	Oct., 1901 P. 313	Feb., 1902 P. 49	April, 1902 P. 119	June, 1903 P. 210	June, 1902 P. 200	Sept., 1902 P. 283	Jan., 1902 P. 15	Oct., 1900 P. 312	Feb., 1903 P. 63	June, 1902 P. 199	Dec., 1901 P. 373	April, 1902 P. 115	Mar., 1903 P. 87

COMOTIVES.

2-8-0	2-8-0	2-10-0	4-8-0	2-8-0	4-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-10-0	2-8-2	2-10-0	0-10-0
Consol.	Consol.	Decapod	Mastodon	Consol.	Mastodon	Consol.	Consol.	Consol.	Consol.	Decapod	Mikado	Decapod	Geared
Erie	Nor. Pac.	Soo	Gt. N.	A. T.& S. F.	Ill. Cent.	L. V.	N. Y. C.	Union	B. & L. E.	A., T. & S. F.	A. T. & S. F.	A. T. & S. F.	Rock Island
1565	Y-3	600	100	824	640	....	G 4	95	150	989	900	940	165
American	American	Baldwin	Brooks	Baldwin	Brooks	Baldwin	American	Pittsburgh	Pittsburgh	American	Baldwin	Baldwin	Lima
Tandem Compound	Tandem Compound	Vauclain Comp.	Simple	Vauclain Comp.	Simple	Vauclain Compound	Tandem C	Simple	Simple	Tandem C	Vauclain Compound	Tandem Compound	Simple
1902	1901	1900	1898	1902	1899	1898	1903	1898	1900	1902	1902	1902	1902
209,000	209,500	210,000	212,750	214,600	221,450	225,082	227,000	230,000	250,300	259,800	261,720	267,800	291,000
185,600	185,500	185,100	172,000	191,400	181,400	202,232	201,000	208,000	225,200	232,000	199,670	237,800	291,000
23,500	24,000	24,900	40,750	23,200	40,050	22,850	26,000	22,000	25,100	27,800	27,250	30,000	....
......	....	....	....	....	....	....	....	....	....	....	34,800	....	....
125,000	empty 47,000	124,550	96,000	110,000	147,600	121,000	133,850	104,000	141,100	134,900	162,000	....	(empty) 62,500
15-6	15-0	19-4	15-10	15-4	15-9	15-0	15-0	15-7	15-7	20-0	16-0	20-4	44-5
24-3	23-8	28-0	26-8	24-6	26-6	23-10	23-7	24-0	24-4	28-11	31-6½	29-10	44-5
52-1¾	52-4½	58-3	53-11	54-2¾	60-2½	55-0½	59-1	54-9½	57-11¾	62-0	62-0	59-6	54-4
56	55	55	55	57	57	55	51	54	54	57	57	57	40
16 & 30	15 & 28	17 & 28	21	17 & 28	23	18 & 30	16 & 30	23	24	17½ & 30	18 & 30	19 & 32	15
30	34	32	34	32	30	30	30	32	32	32	32	32	17
210	173	201	235	165	263	215	201	205	241	205.4	210.3	210.3	156
......	22.9	....	....	....	....	....	26	....	....	....	....	23.9	....
[illegible]	3,450.4	2,799	2,730	4,031	3,237	3,890.6	3,915	3,116.5	3,564	4,476.5	5,155.8	5,155.8	1,837
[illegible]	3,646.3	3,000	2,965	4,266	3,500	4,105.6	4,142	3,321.5	3,805	4,681.9	5,366.1	5,390	1,993
[illegible]	100 1-16	132	123	84	132	120	105	120	132	108 1-16	108	108	96
[illegible]	75¼	41	39¾	3-28 dia.	41¼	108	79	40.5	40.25	79¼	78	78	54
[illegible]	52.3	37.5	34	....	37.5	90	58	33.5	36.8	59.5	58.5	58.5	36
[illegible]	74¾	68	78	74	80⅛	80	77	80	84	78¾	78¾	78.75	60
[illegible]	9-3¼	8-11	9-5	9-2	9-8	8-7⅜	9-3	9-3⅜	9-11¾	....	9-10	....	....
[illegible]	442-2	344-2	376-2¼	652-1¾	424-2	511-2	507-2	355-2¼	406-2¼	413-2¼	463-2¼	463-2¼	270-2
[illegible]	15-0	15-7	13-10⅝	13-7	14-8⅜	14-7¾	14-9	15-0	15-0	18-6	19-0	19-0	13
[illegible]	210	215	210	210	210	200	210	200	220	225	225	225	190
Straight	Wide box	Extended Wagon top	Belpaire	Extended Wagon top	Belpaire	Wootten	Extended Wagon top	Straight	Straight	Extended Wagon top	Wagon top	Wagon top	Wagon top
[illegible] coal	Bitum. coal	Bitum. Coal	Bitum. coal	Oil	Bitum. Coal	Ant. coal	Bitum. coal	Bitum. coal	Bitum coal	Oil	Bitum. coal	Bitum. Coal	Soft coal
[illegible] 1902 P. [illegible]6	....	Oct., 1900 P. 319	Jan., 1898 P. 1.	Jan., 1902 P. 10	Oct., 1899 P. 315	Dec., 1898 P. 395	May, 1903 P. 174	Nov., 1898 P. 365	July, 1900 P. 214	Feb., 1902 P. 38	Jan., 1903 P. 16 and Mar., 1903, P. 109	June, 1902 P. 192	Aug., 1902 P. 244

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WEAKNESSES IN M. C. B. KNUCKLES.

Whenever Mr. G. W. Rhodes says or writes anything on a mechanical subject connected with his life work it is sure to be important. The attention of railroad officers is directed to his strenuous appeal for the relegation of link slots and pin holes which he presents in his article on page 243, this issue. When he says, "There is nothing more serious or disastrous on a railroad than a break-in-two with a freight train," he voices the feelings of all who understand train operation. It is to be hoped that this forcible statement of the situation will result in the banishment of this fault from the M. C. B. knuckle and that it will be done at Saratoga at the coming convention.

"AMERICAN ENGINEER" TESTS.

Professor Goss has completed the series of tests on stacks, and in this issue his conclusions appear. These are printed now in order to place the results before the readers at the time of the Master Mechanics' convention, and the remaining portion of the record will be presented later.

At the 1902 convention of the Master Mechanics' Association, in accordance with a suggestion by President Waitt, the executive committee was instructed to assist in the tests, and a special committee was appointed to co-operate with THE AMERICAN ENGINEER in the work. This committee met a representative of this journal in October last and arranged for tests to be made on several railroads, to check the conclusions of the report with results obtained in service. This committee will report at the approaching convention.

The next step will be to take up the investigation of the front-end problem in large locomotives.

THE OPPORTUNITY OF THE MASTER MECHANICS' ASSOCIATION.

Those who are watching the career of the American Railway Master Mechanics' Association with the greatest interest believe that it is now facing an opportunity which is in many ways the most important which has ever come before it.

In his presidential address last year Mr. Waitt directed attention to the desirability of conducting tests under the direction and financial responsibility of the association, through which many questions relating to the efficiency of operation of locomotives may be studied; and this is the opportunity to which the attention of railroad officers should be directed.

At times most excellent and valuable investigations have been made by the association, of which the exhaust nozzle tests of 1896 are a conspicuous example. With the growth of the locomotive and the advances of the present time in methods of designing and maintaining, it is specially necessary that various very important questions should be carefully investigated and reported upon by experts working under the direction of those who are responsible for locomotive operation, and this cannot be properly done except by this organization or under its direction and control. The work must be controlled and directed by those who know the needs and who can eliminate all question of personal opinion or advantage.

Perhaps THE AMERICAN ENGINEER Tests have given an impetus to the idea of the necessities of a thorough, systematic study and investigation of features of locomotive design, but whether or not this is the cause at the present time, two committees will report this year upon the subject of tests and the association will soon consider ways and means for providing for tests under the auspices of the association.

The reason why this offers a great opportunity to increase the usefulness of the association is that it presents a method of uplifting the whole mechanical department to a higher plane of usefulness by furnishing information which should control and direct the efforts of locomotive men in an intelligent way which may be immediately reflected in the commercial results of operation. For this reason the railroads can well afford to give generous financial support.

The railway clubs are doing in an admirable way much of the work formerly falling to this association, and it seems desirable in every way to give a large proportion of attention to investigation and to other work which none but a national organization can do.

The strength of the Master Car Builders' Association lies in the fact of its representative membership in matters connected with car interchange. The Master Mechanics' Association would be wise to obtain the advantage of representation of the railroads which would necessarily follow the inauguration of the policy under discussion.

Many new problems are arising, and these all involve commercial questions of large investments. Some of them may be mentioned as general lines for investigation. For example, we have the big engine, compounding, valve gears, superheating, water purification, power house practice, motor driving of machine tools, cuts, feeds and speeds of machine tools. All these are important questions which involve large expenditures which should be administered with the utmost possible intelligence rather than by the cut and try policy which must necessarily prevail in the absence of definite knowledge of cause and effect which well considered tests would disclose.

FLYWHEELS ON PLANER DRIVES.

The recent criticism by the *American Machinist* of the article by Mr. J. C. Steen, entitled: "Driving Planers," appearing in our May issue, gives evidence of a failure to carefully read the article. The article was, *in no sense* a record of a test of a planer drive, being nowhere so stated. It was written to describe, briefly, a condition of planer driving that had existed for several years. The scope of the article was not extended to a consideration of the causes of the increased demands for power made by planers at reversals of their platens' motion; had it been intended as a treatise upon planer driving, this feature would have been discussed.

The author, Mr. Steen, was well acquainted with the fact that the inertia of the pulley wheels in a planer's drive is largely responsible for this phenomenon. Furthermore, this subject was only recently treated in our columns, in an article relating to the application of fly-wheel drives to some of the motor-driven reciprocating tools at the Collinwood shops of the Lake Shore & Michigan Southern Railway (see page 102, of our March, 1903, issue).

We are more than surprised that the *American Machinist* also takes the stand of questioning the advisability of applying fly-wheels to planer drivers in which it is known that heavy extra-power demands are made. It is stated in their editorial: "The fly-wheel will, no doubt, reduce the surge of current, but, in doing this, it prolongs the time during which the increased current must act," etc. Now this result is *exactly what is wanted!* It is not expected, nor intended, to reduce the *work* of reversal, but the great desideratum is to "prolong the time" during which the current acts, so that the objectionable peak of the load curve is flattened down. This will greatly reduce the severity of the shock to the motor and also will reduce the extreme and abnormal rush of current which is so detrimental to the electrical distribution circuit.

The *American Machinist* has also, in the editorial, inadvertently confused terms in stating that a motor of the constant-speed type is not "suited to the purpose" of driving planers, for which a differentially wound (over-compounded field) motor should be used. The differential wound motor, with over-compounded fields, is nothing more nor less than a constant-speed motor, the over-compounding being used purposely to maintain its speed constant by greatly increasing the torque in the armature at every tendency to slow down due to an increased demand for power. Mr. Steen's use of the term, "constant-speed motor," was merely that necessary to distinguish the type used from the variable-speed type, such as the multiple-voltage, double-commutator and other types.

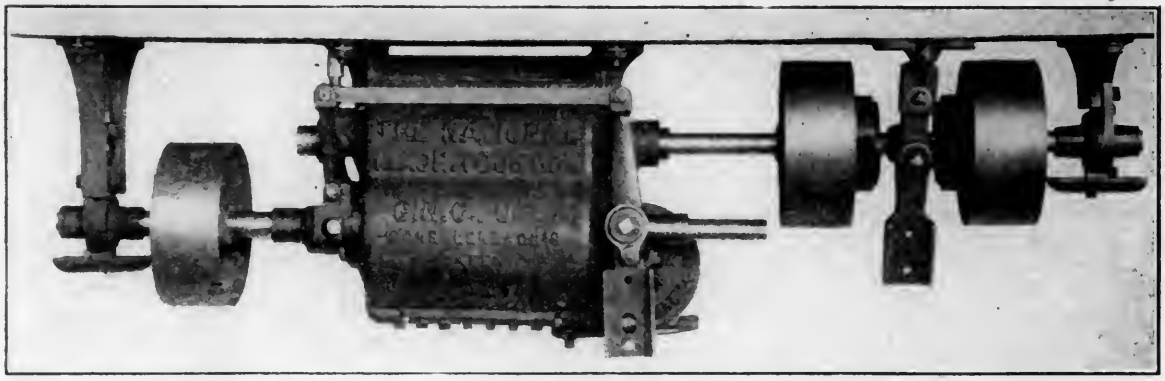


FIG. 27.—EXTERIOR VIEW OF THE SPEED "VARIATOR," AS EQUIPPED WITH REVERSING CLUTCHES FOR LATHE DRIVING.

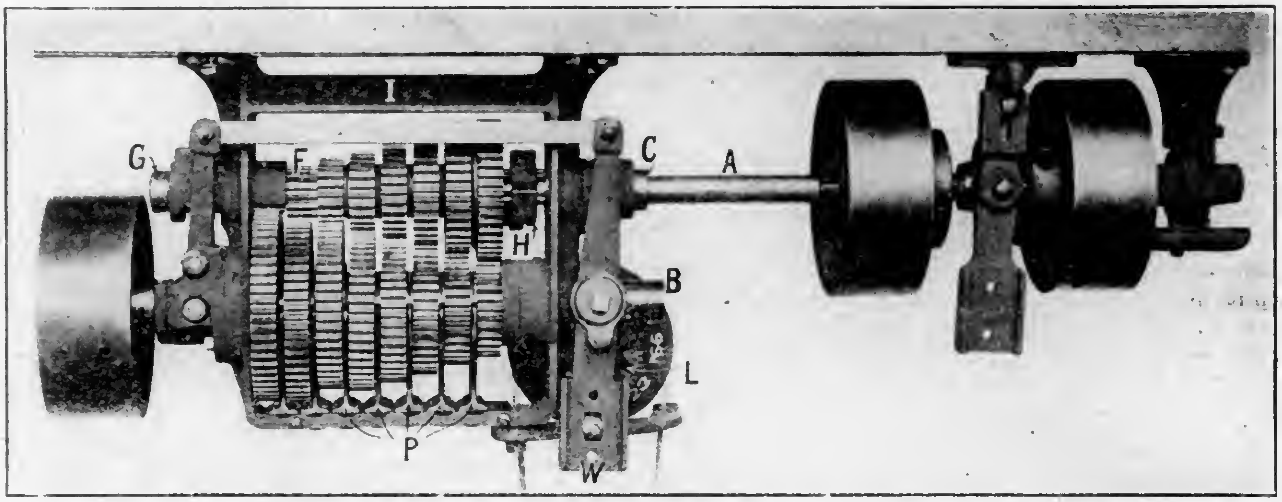


FIG. 28.—FRONT VIEW WITH COVERS REMOVED, SHOWING SHIPPER LEVER AND CONNECTING ROD TO SLOW-SPEED CLUTCH.

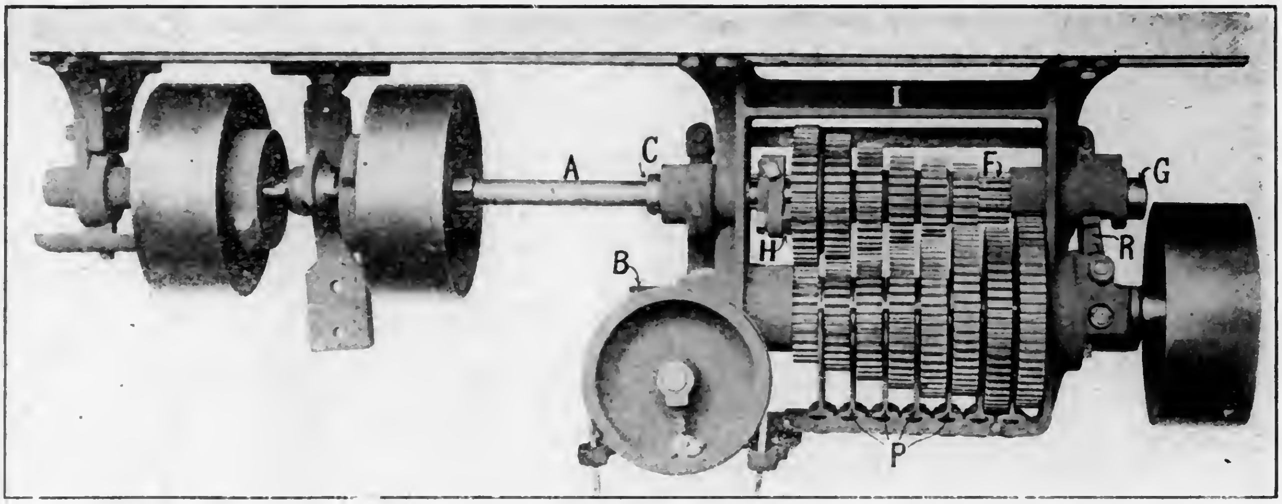


FIG. 29.—REAR VIEW WITH COVERS REMOVED, SHOWING ROPE SHEAVE FOR SHIFTING SLIDING CONE.

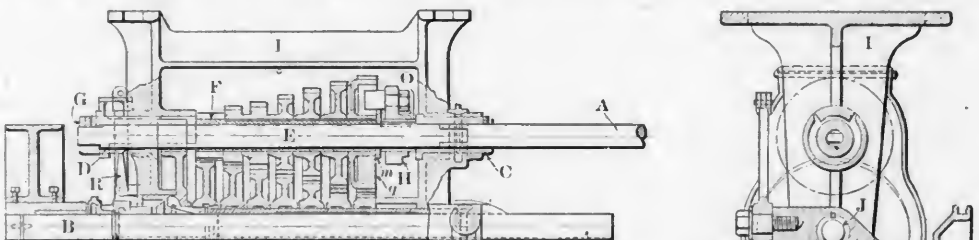


FIG. 30.—LONGITUDINAL SECTION AND CROSS SECTION THROUGH SHIPPER MECHANISM.

THE SCHELLENBACH VARIABLE-SPEED DRIVING MECHANISM.—NATIONAL MACHINE TOOL COMPANY.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

VI.

BY C. W. OBERT.

The third article of this series (page 98, March, 1903) described an independent, detachable feeding mechanism, applicable to lathes of any design, which is built by the National Machine Tool Company, Cincinnati, Ohio. The National Machine Tool Company are also building an independent variable-speed main driving mechanism of very interesting design which is applicable to the driving of all types of machine tools and other machinery requiring variable-speed drives. The latter device is of particular interest at the present time, owing to the greatly increasing use of electric driving by constant-speed motors. This speed "variator" makes available a wide range of speeds from a constant-speed drive, the changes being easily obtainable without the trouble of changing belts. It is being largely used in connection with constant-speed drives, both from motors and from line shafting, with marked success.

In the form shown in the exterior view of this device (Fig. 27) it is intended for use as a countershaft drive for lathes and other machine tools, but its construction is such as to enable it to be adapted for use in any manner or in any place where changes of speed are required between wide limits. And recent improvements in the method of changing the gear ratios have rendered it capable of withstanding the most severe service.

The principle of the speed variator is made clear in the following engravings. Figs. 28 and 29 present front and rear views of the mechanism with the protecting covers removed, while Fig. 30 shows a sectional elevation of the mechanism.

The general principle upon which the mechanism operates is the familiar one of two cones or nests of gears arranged upon parallel shafts for the proper meshing. The driving shaft A, Figs. 28-30, is carried in a sleeve (C), to which it is fastened to prevent end movement, and is milled out at the left-hand end in order to clutch with a sliding pinion shaft (E, Fig. 30). Mounted loosely on shaft E is a pinion (F), which has a long sleeve passing through, and upon which are keyed the larger gears of this cone of gears.

On the shaft E, which rotates at all times with shaft A, is a pinion (at the left of pinion F), which runs in mesh with the largest gear of the lower cone. The bushing D is slotted on its lower side to receive the upper end of the rocker R, and when this rocker is operated both bushing and shaft are moved endwise. There is also a flange (H) at the right-hand end, which is keyed and clamped to move with shaft E between the largest gear and the frame, and is provided with a taper wedge which fits a corresponding taper in the split friction ring Q in the gear. A washer (M) is placed on the shaft to serve as a retainer for ring Q, and between the washer and the sleeve C are vertical pins (O) passing loosely through flange H, which prevent the gear-cone from moving endwise. It may be seen that when the shaft is moved by the bushing D and rocker R the cone of gears will be locked to it or unlocked by the friction ring Q.

In most mechanisms of this kind the loose gears are in mesh with the driving gears all the time, so that all rotate at their respective speeds without regard to which gear is carrying the load; in this device the loose gears are bored out larger than the diameter of the shaft B, and when not in action drop out of mesh and simply hang suspended with their teeth just out of contact with the teeth of the driving gears. The hubs of the loose gears are prolonged so that when the gears have dropped out of mesh the hubs will be supported upon the separating pieces PP and keep the top surfaces of the bore of the gears out of contact with the rotating shaft.

The bore of these gears is the same as the outside diameter of the sliding cone, which lifts the gears into mesh with their drivers. This cone has a spring key and is moved along through the gears by the sliding sleeve J, the latter having on its under side a rack which engages with the gear L. The inside of each gear is beveled at the same angle as the outside of the cone, and the keyways provided in them are so located that when the cone is shifted from one gear to another the new gear shall be fully engaged and the old one entirely disengaged before the spring key can get into a keyway and so lock the driven gear to the shaft.

The largest one of the lower cone of gears is constantly in mesh with the pinion on shaft E; the hub of this gear takes its bearing in the bore of the boss on the lower left-hand end of frame I. This hub is provided with a friction clutch which is operated by the wedge collar K splined to the shaft B. The collar is moved on the shaft by the rocker R, this rocker having a fork at its lower end provided with a shoe fitting a groove in the collar.

The gear L which operates the sliding cone is keyed to the short shaft shown in the cross-section view (Fig. 30), which shaft has a rope sheave upon its end. The gear L has as many radial grooves milled in its face as there are gears on the lower shaft, and a spring-seated plug in front of it has a roller which engages these grooves. To the left of this plug is another plug made slightly conical to bear against the pointed screw shown in the lever W. This lever is connected at its upper end with rocker R by a flat connecting rod (shown in Fig. 28) and has a shipper handle bolted into the pocket shown at the lower end.

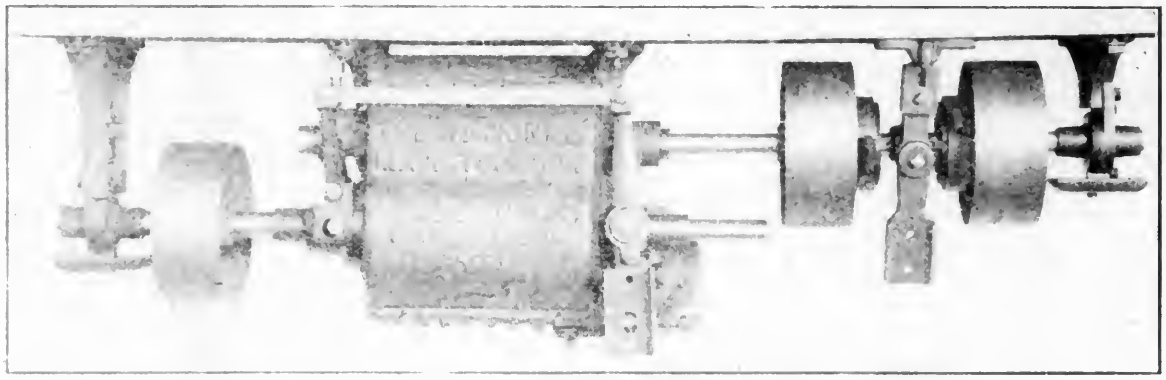
When the shipper is moved to the right it releases the friction in the large gear of the lower shaft and locks the upper gears to shaft E, for driving; when to the left, the upper cone is released and the lower large gear is locked to its shaft. Thus the power is removed from the upper gear-cone and the lower shaft driven slowly during the speed-changing operation; for the shipper must be moved to the left before the rope sheave can be turned to move the sliding cone.

Referring again to the cross-section, it will be seen that the pointed screw in lever W bears against the point on the spring-seated plug when the upper cone of gears is locked to shaft E. At this time the inner surfaces of the two plugs are in contact and the roller has not sufficient lateral movement to get out of the groove in gear L, but when the shipper is moved to the left, thus releasing the upper gears and locking the large gear below to its shaft, the pointed screw moves out of line with the point on the spring plug, and the sheave may then be rotated to any desired position. But should it be rotated so as to bring the lower sliding cone between two of the gears, the spring-seated plug will be forced out sufficient to lock the lever W in such a position that the upper gears cannot be locked to shaft E.

This attachment makes it possible to run the countershaft at a very high rate of speed without danger of breaking the gears when the speed is being changed. Also, with this arrangement the cone and key on the lower shaft can be moved very quickly from one end to the other.

This device approaches very closely to the ideal mechanism for the gradual shifting to higher or lower speeds which is characteristic of all frictional variable-speed devices. It is very strongly built, being intended for the most severe service, and has the great advantage of preventing double gear combinations which result in stripping gear-teeth, and also the possibility of severe shocks at speed-changes is eliminated.

The Twentieth Century Limited made a remarkable run from Cleveland to Elkhart on the Lake Shore on the night of May 24. The train arrived in Cleveland 1 hour and 32 minutes late, arrived at Elkhart 14 minutes late, and was on time at Dune Park, 35 miles from Chicago. From Cleveland to Toledo, 104.7 miles, was covered in 105 minutes, at 59.8 miles per hour. The engine was class J (AMERICAN ENGINEER, March, 1901, page 60). From Toledo to Elkhart the train was hauled by a class I engine (November, 1899, page 343) at a speed of 70 miles per hour, or 133 miles in 114 minutes. The train consisted of a buffet smoker, two sleepers and an observation car. This record is sent from the official train sheets by Mr. H. F. Ball.



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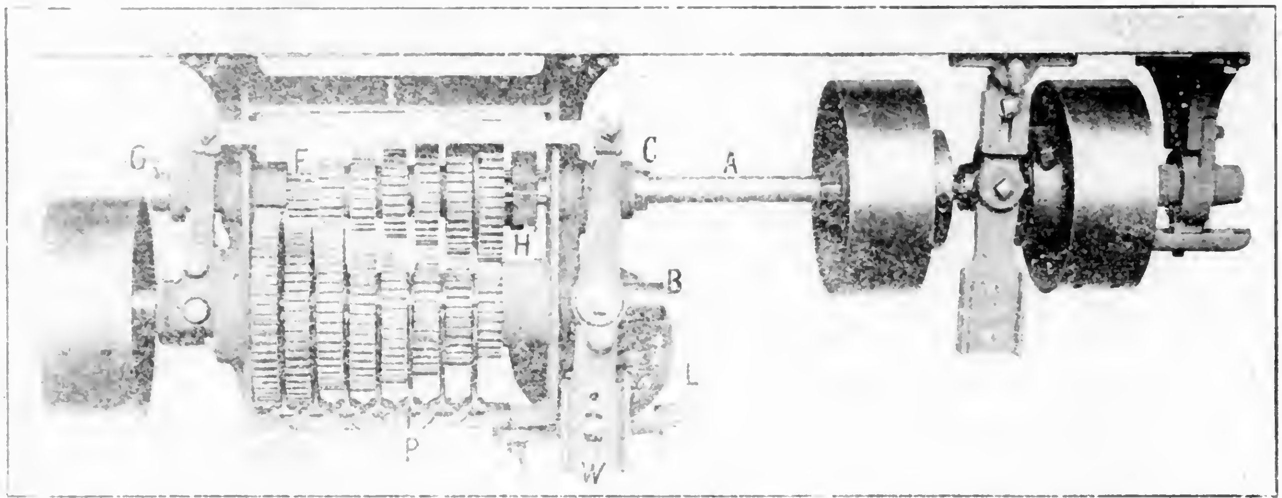

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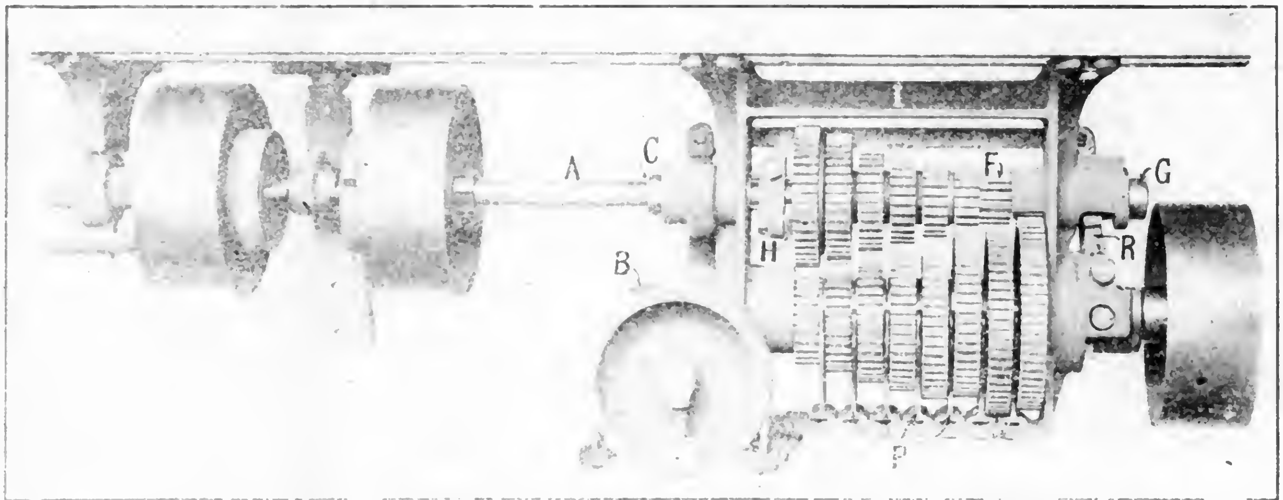

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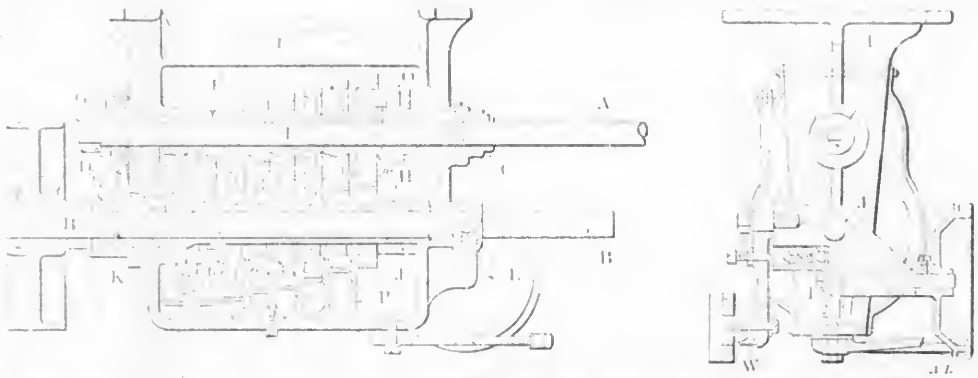

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MACHINE TOOL PROGRESS.

Feeds and Drives.

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By C. W. Obert.

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LEAKY FLUES AND CIRCULATION

In Wide-Firebox Locomotives.

BY JOHN PLAYER, MECHANICAL ENGINEER, BROOKS WORKS, AMERICAN LOCOMOTIVE COMPANY.

The leakage of flues in wide-firebox boilers is due to several different causes, some of which do not exist in narrow fireboxes. Among the chief causes of the trouble is a series of local conditions, the first of which is the class of fuel used; second, the inexperience of firemen and engineers in handling wide-firebox engines; third, the ignorance of the hostlers and those in charge of engines at terminals in handling this type of engine.

With regard to the type of fuel used, sufficient attention has probably not been paid in the design of medium-wide firebox boilers for burning bituminous coal to the proper grate area required for the different classes of coal. In narrow-firebox engines all that was necessary was to get in as large grate area as possible. In some of the wide-firebox designs too large a grate area has been introduced for burning the class of coal required. This subject is receiving closer attention than originally, and we expect ere long to be able to determine more accurately the correct grate area for different classes of fuel in different sections of the country. When this has been accomplished one of the causes of leaky flues will be removed.

With regard to the second item—inexperience of firemen: This gradually disappears as the firemen become more experienced in handling wide-firebox engines. Especially is this true if the roads operating them have intelligent traveling engineers or practical traveling firemen who conscientiously take hold of this subject and instruct the firemen properly.

Third, the ignorance of hostlers can be eliminated by conscientious work on the part of roundhouse foremen and others in charge of terminals to see that the hostlers handle the wide-firebox engines properly and do not, as is generally the practice, dump the fire out of doors, leaving the blower on full, and consequently inducing a great amount of cold air to come in contact with the flue-sheets.

The other causes of leakage of flues in wide-firebox engines are largely due to error in design or to restrictions placed by the railroad company upon builders, as follows:

In a wide-firebox boiler, owing to the grate being wide and short and of greatly increased area, a far more intense heat is obtained against the flue-sheet than in a narrow firebox, where the grate is narrower and longer, and in which a large proportion of the heat generated in the rear portion of the firebox becomes absorbed by the sides and crown-sheet. The flue-sheets and ends of flues in any tubular boiler will stand a certain degree of heat without injury. However, when this temperature is greatly exceeded injury is caused, from the fact that this increase of temperature has an annealing effect upon the ends of the flues, reducing the tension therein which has been created by rolling and expanding them in the sheets and by beading them over, these mechanical operations upon the flues having a tendency to harden them in the sheet. This action removes the tension therein and practically loosens them in the sheet, thus causing leakage. In order to guard against this increase of temperature in the ends of the flues and flue-sheet, better and freer circulation must be provided. This can only be accomplished by increasing the spacing of the flues, more especially the horizontal spacing, so as at all times to ensure an ample supply of water in contact with the sheet and flue ends. Some builders and many railway companies insist upon inserting a superabundance of flues in boilers, especially of the wide-firebox type, desiring to outstrip their competitors in the number of square feet of theoretical heating surface which they can show on paper as contained in their engines. However, it takes something more than theoretical heating surface to make steam and produce a satisfactory engine. A sufficient supply of water at all times in contact with the effective heating surface is far more necessary than an absurd amount of heating surface which cannot be utilized from lack of water to evaporate. A good and free circulation in a boiler is also of the greatest importance.

Another point which has been in the past, and is at the present, overlooked by locomotive designers, builders and users is the fact that not only must means for ample circulation be maintained, but also that this circulation must be uniform at all times, or, in other words, that a change or disturbance in the circulation produces detrimental results. It is, I think, a well-established fact that where two injectors are used, delivering water through two separate check valves located on opposite sides of the boiler at the front end, when the second injector is applied the steaming qualities of the engine are temporarily reduced. This is not due, as many would claim, without reasoning, to the additional amount of water injected into the boiler, but to a temporary disturbance in the circulation of the water in the boiler, for has it not been demonstrated that when the water is delivered from the second injector through a duplicate check or elbow at the same point as from the first injector, practically no reduction in pressure is observed when the second injector is applied? This would seem to prove conclusively that the effect on the steaming qualities was due to a disturbance in circulation caused by introduction of feed water into the boiler at another point. Furthermore, if this matter is given sufficient thought and the proper course of circulation in the boiler followed, does it seem right to apply the feed water against the flues half-way up the side of the boiler at a point where such application will materially disturb the natural circulation? Would it not be better to apply the feed water at the bottom of the boiler, toward the front end, providing a discharge backward toward the firebox flue-sheet, which is the natural course for the circulation to take? I have often noticed in boilers where the checks are applied to the back head or otherwise through internal pipes, discharging the water toward the front flue-sheet instead of splattering it all over the flues, that the application of the first or second injector with such arrangement has far less effect upon the steaming qualities of the boiler than with the use of side checks. This is simply due to the fact that although the introduction of the feed water is not in the theoretically correct course of the natural circulation in the boiler, it far more nearly approximates it than the erroneous application on the side.

If the matters I have outlined above are given proper attention, I fail to see why trouble should be experienced from leaky flues in wide-firebox boilers.

Editor's Note.—Mr. Player's discussion is supplemented by a report of an interesting test of firebox conditions from another source, as follows:

A Test of Firebox Conditions.

It is startling to be told that firebox sheets (side sheets) become dry, but this seems to be the fact when engines are working hard. The following is quoted from a report to the superintendent of motive power of a road where great difficulty is experienced in the cracking of side sheets of engines not more than 18 months in service:

"We have completed our test of engine No. — to determine the dryness of steam adjacent to the firebox. We first used glass water gauges on the sides, but these showed water at all times. We next placed gauge-cocks with extension tubes on the sides, about midway of the length of the firebox, the lower gauge being about 16 ins. above the mud ring, the second 6 ins. higher, and the fourth gauge about 40 ins. above the mud ring. The ends of the extension of the gauge-cocks projected through the water space to within ⅛ in. of the water side of the inside firebox sheet. These extensions were gradually shortened until the ends were ¾ in. from the inside sheet.

"We find from this experiment that when the engine is working hard there is a zone of practically dry steam covering the central portion of the side sheet; that is to say, the evaporation is so rapid that the sheet under these conditions is at times dry. The zone appears to start at zero and increase in thickness as it extends upward. At the center of the sheet there is about ¾ in. of practically dry steam. It is not con-

stant, nor is the distance from the firebox a fixed one, but it varies as the fire is pushed and the height of water increases. It appears that the zone is thicker when the water is low. The sudden lurching or swaying of the boiler appears to throw water against the sheet. This is evident from the fact that there may be a steady flow of steam for a few seconds, then water, and so on. Upon opening one of the cocks water will flow, later steam. If the cocks are left open, it seems as if a suction is produced on the inner end of the tube which draws the water out.

"We know that the temperature ⅛ in. from the inside sheet on the water side is at times 435 deg. This is above the temperature of steam at 200 lbs. pressure by 54 deg. The temperature may be even higher. This we shall demonstrate very soon. From the fact that all of the cracked sheets appear to be burnt it is evident that the temperature of the sheet is much higher than 435 deg. It could not on the water side be above 381 deg. at 200 lbs. pressure if water were constantly against the sheet. These facts support the theory of dry steam being present against the sheet under the above conditions."

On new engines this road has had many cracked and bulged side sheets. The cracks are nearly always vertical and the steel is covered with minute cracks, parallel and vertical, very closely resembling burnt steel; yet the steel was satisfactory under tests. The cracks have developed in the roundhouse when firing up or washing out. They are often accompanied by loud reports, indicating high internal stresses in the firebox structure. These facts indicate the necessity for a thorough study of firebox conditions, and they point to the importance of improved circulation.

LIGNITE BURNING IN LOCOMOTIVES.

BURLINGTON & MISSOURI RIVER RAILROAD.

ANALYSES OF SMOKEBOX GASES.

BY M. H. WICKHORST, ENGINEER OF TESTS, C., B. & Q. R. R.

While making some tonnage rating tests with a dynamometer car for the B. & M. R. R. about a year ago the writer also took occasion to make analyses of the smokebox gases and it was thought it would be interesting to give results of experience with the burning of lignite coal in locomotives in Montana on the Sheridan Division of that road, together with methods and results of smokebox analyses.

GENERAL REMARKS.

Along the line of the B. & M. R. R. in Wyoming and Montana two kinds of fuel are available for locomotives, namely, bituminous coal obtained from Cambria, Wyo., and lignite coal now obtained mostly from Dietz, Wyo., just out of Sheridan.

The bituminous coal is a low grade containing very high percentage of ash, quickly filling ash pans and firebox, although it has the redeeming feature that it does not readily clinker. The lignite coal is low in ash, but contains considerable moisture. The lignite coal requires but little labor in taking care of ashes and it does not fill up the firebox, but its worst feature is that it does not coke and is very light, and consequently throws sparks furiously with the ordinary front end construction for bituminous coal. The sparks, too, hold fire a long time.

Here is given the average analysis of the two coals:

	Cambria Bituminous. Per Cent.	Sheridan Lignite. Per Cent.
Moisture	5	17
Volatile Matter	5	35
Fixed Carbon	40	40
Ash	20	8

It will be noted in the above composition that the volatile combustible matter and the fixed carbon are about the same in the two coals, the bituminous coal containing a low amount of moisture and a high amount of ash, while the reverse is the case with the lignite coal. While the heat units generated by each coal would be practically the same, the heat actually available would be greater with the bituminous coal, due to the fact that with the lignite coal the great amount of moisture absorbs and carries away some of the heat. This moisture also becoming steam, takes up considerable room, thus increasing the volume of smokebox gases per unit of heat.

The considerable inconvenience and loss resulting from the high percentage of ash in the bituminous coal causing ash pans and fireboxes to fill up so very quickly, and expense of handling ashes led to experiments with lignite coal, particularly as lignite had been used for fuel in locomotives by some roads further south.

DESIGN OF FRONT END AND GRATES.

In changing a locomotive to burn lignite coal that has been burning bituminous coal the two important changes are; First, to use a front end arrangement that will be effective in preventing sparks, and, second, to use finer grate openings so as to prevent coal from dropping into the ash pan. The first engine changed was in January, 1901, and soon after that other engines were changed on the Sheridan Division. The front end arrangement as adopted for the Class D-3 engines, which are large consolidation freight engines, is shown in Fig. 1, and grates of Class R-2 engines, which are "Prairie" type freight engines, are shown in Fig. 2.

REMARKS ON COMBUSTION AND COMPOSITION OF SMOKEBOX GASES

The parts of coal that are of value for developing heat are the elements carbon and hydrogen, most of the heat being obtained by the combining of oxygen with the air with the car-

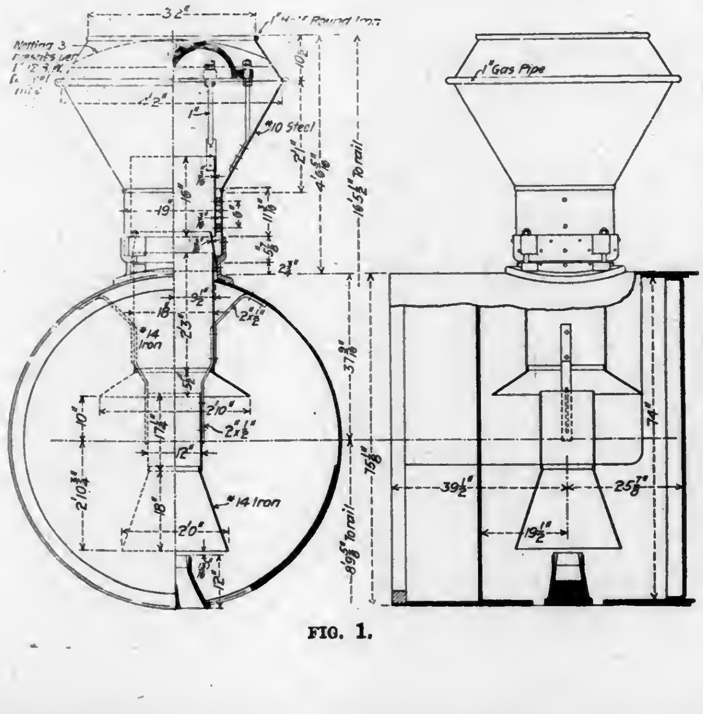

FIG. 1.

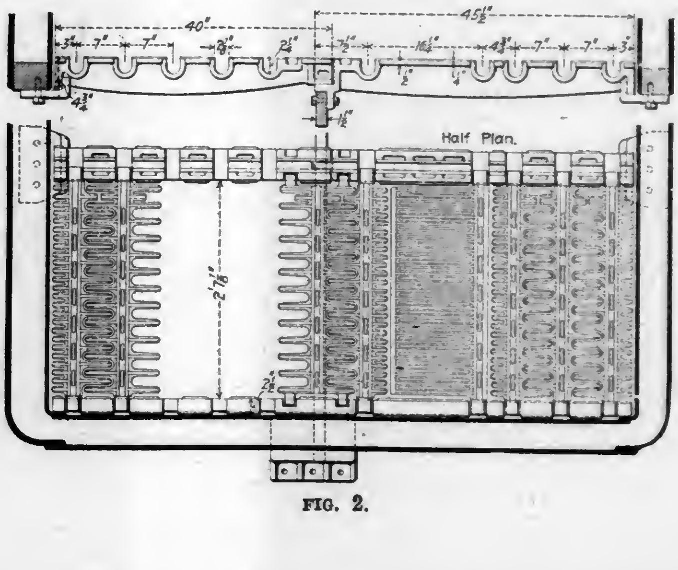

FIG. 2.

bon in the coal, but some also being obtained by the combining of hydrogen with oxygen. In an analysis of coal the volatile combustible matter and moisture represent the portion that volatilizes and forms when coal is thrown into the fire. The moisture is of no value for producing heat, but on the other hand is detrimental by absorbing heat and carrying it off, and is also detrimental by increasing the volume of smokebox gases. The volatile combustible matter in being converted into gas absorbs heat, but in combining with oxygen of the air gives out heat in considerable quantity. The components of the volatile combustible matter that are useful for heat production are carbon and hydrogen. The fixed carbon does not volatilize, but remains upon the grates until the oxygen of the air comes along to combine with it when it is converted into carbon monoxide or carbon dioxide, according to the quantity of oxygen available. The air necessary for combustion consists principally of two gases—oxygen and nitrogen; the active gas in combustion is oxygen and composes about one-fifth volume of the air, while the nitrogen is inert, taking no active part in combustion, simply acting to dilute the oxygen.

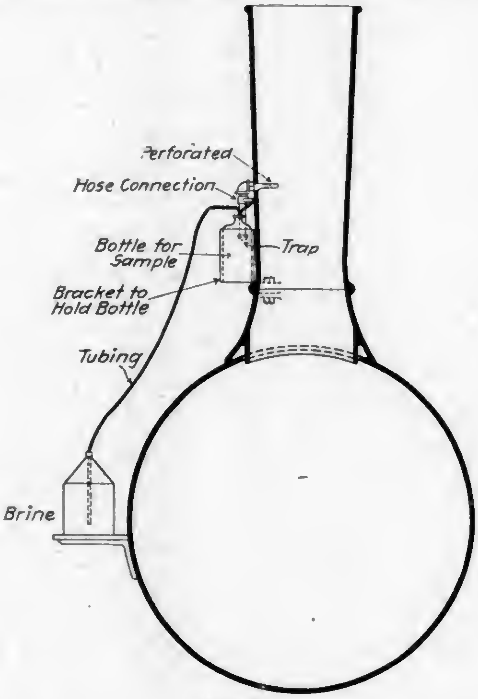

FIG. 3.

Carbon is a solid substance, but when it combines chemically with the gas oxygen under conditions of complete combustion the product is the gas carbon dioxide, chemical symbol of which is CO_2, heat being one of the physical effects of this chemical combustion. Where carbon combines with limited supply of oxygen the gas carbon monoxide (CO) is formed with a production of only about one-third of the heat in the previous case. Hydrogen is a gas which combines with the gas oxygen to form water (H_2O), which is liquid at ordinary temperatures, but is a gas or steam above 212 degs. at atmospheric pressure, considerable heat being one of the physical effects.

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COLLECTION OF SAMPLE OF GAS.

For the purpose of collecting a sample of gas for analysis we used the arrangement shown in Fig. 3. The sampler consists of a perforated pipe extending a few inches into the stack and has a trap attached to it to catch cinders. The bottle in which the gas sample is to be collected was filled with a strong solution of salt to start with and this was syphoned out into a can on the running board as shown, the gas sample going into the bottle to take its place. The sample of gas is then taken into the test car behind the engine, where it is analyzed. The brine is syphoned out at such a rate as to let the gas sample cover a period of 15 minutes' firing. The gas sample is also handled under such precautions as to avoid its escape or mixture with air.

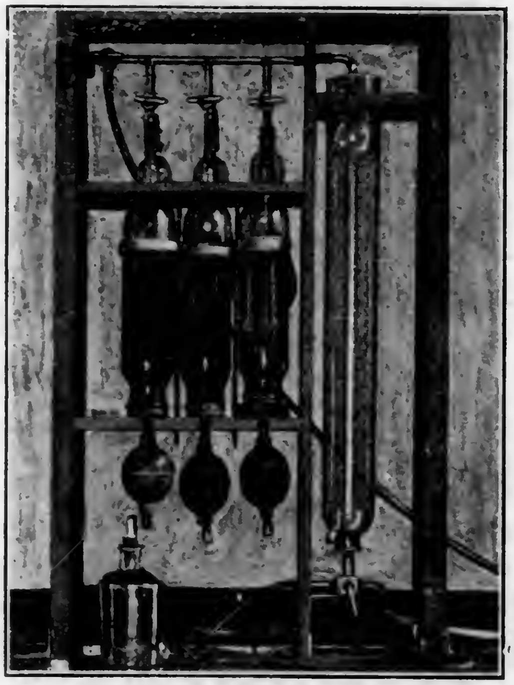

FIG. 4.

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Having obtained 100 cubic centimeters of the gas sample in this apparatus the carbon dioxide is first absorbed by a solution of potassium hydrate and its amount determined by reduction in volume. The oxygen is then determined by absorption in alkaline pyrogallic acid solution in a similar manner and carbon monoxide by absorption in cupric chloride solution. For further details on method of analysis I refer to books on gas analysis.

RESULTS OF ANALYSIS FROM BURNING LIGNITE COAL.

Perfect combustion with lignite coal would show about as follows: CO_2, 18 per cent.; CO, 0 per cent.; O, 0 per cent. This would be under ideal conditions. With bituminous coal, very good practical results would be about as follows: CO_2, 12 per cent.; CO, 0 per cent.; O, 6.0 per cent.

I give below a table showing about the average results obtained from analysis of smokebox gases by burning lignite coal:

CO_2	O	CO
11.8	5.9	0.3
12.9	6.0	0.3
11.5	5.9	0.4
14.1	4.6	0.7
12.1	2.9	3.7
13.6	4.8	0.0
12.0	7.9	0.0
13.6	1.8	2.9
13.9	4.0	1.2
13.1	4.7	0.4

THE PIECE-WORK SYSTEM FROM A PIECE-WORKER'S STANDPOINT.

BY H. B. KEPNER.

Having been a piece-worker and made a practical study of the piece-work system for over five years, from its very inception almost, as applied to locomotive repair shops where at one time it was considered impracticable if not impossible; having labored in every department of machine shop work under the system during that time, and having had my attention called to the subject by articles appearing from time to time in various publications where a great deal of speculative argument is being produced both for and against the system, I am convinced that the amount of practical knowledge as to its fairness, as well as to the best plans for its adoption, is very limited and that we are yet to see it put into a great deal more general practice. So I believe it to be a subject well worthy of our most careful consideration.

As to the justice of the piece-work system from the standpoint of the employer, but little need be said, for to him it is a plain proposition of "Paying for what you get." However, as will be shown further on, much depends upon him whether the system proves a success or a failure, or rather whether it becomes popular or unpopular among his workmen.

But, upon the other hand, viewing it from the side of labor, much might be said and much is said. Many colored views are taken and considerable difficulty arises in the introduction of piece-work. So many biased opinions are expressed that the uninitiated are led to fear its possibilities and to distrust the fairness or the purpose of its promoters. But the honest, intelligent workman ever desires to be reasonable, and by such only can I hope these remarks to be kindly considered, so I would respect every workman as belonging to this class until he should prove himself utterly impregnable to reason. Such a one can only be convinced by experience.

Custom sometimes becomes a law and may control our judgment for a time, whether wisely or not. Prejudice may run away with our reason, but time will bring us to our senses, even though it may be after many a wasted opportunity. So laying aside one's prejudice and treating all men as being fair and reasonable, let us ask where there is any reason why piece-work should be unjust to the workman. Of course, it puts a premium upon skill and tends toward the "survival of the fittest" in reference to workmanship. The best workman may earn the most money, but why should he not?

Let us suppose that two young men of equal ability and like prospects should start to learn a trade and one should diligently apply all his energy, studying at night, working every hour he is able and faithfully striving to become a master of his profession, while the other is impatiently looking forward to the day when his term of apprenticeship shall have expired, seeking diversion at night, neglecting his duty by day, remaining off duty upon the least provocation, as some I have seen do, seeming to think that time is all that is necessary to serve in learning a trade and forgetting that practice alone can develop skill. At the expiration of their apprenticeship, which of these two young men would be the more competent workman and whose services would be worth the more? Naturally, we would answer that the faithful and most intelligent workman will accomplish the most and best work in a given time and his services be worth the most money, not alone for the amount of work done but for the quality as well, while the other fellow you will find to be the one who will do the most kicking against the piece-work system.

There are, however, many conditions to be considered in the successful introduction and practice of the piece-work system. A Chicago paper, in commenting upon this subject recently, mentioned as an objectionable feature, the unfair advantage it gives to unscrupulous and dishonest foremen who may, if they choose, materially affect the pay of any workman by the assignment of work. Certainly the charge that any foreman or minor official does, through personal feeling, make such use of the authority vested in him should be sufficient to disqualify him, but fortunately such cases are the exceptions and not the rule. So this objection should merely serve to warn us against such persons and bears no weight whatever against the system.

Then, some argue that it discriminates against the weak and less fortunate workman. Labor is often spoken of as a commodity as much as the corn that is sold by the farmer who, by the way, is a piece-worker in the extreme sense of the term, for he must provide his own tools, machinery, material and all facilities and then sell his produce by measure; then the man who lives farthest from the market or has the least facilities for delivering would require the most time in delivering a given amount of corn, for instance, but would we be willing to pay for it according to time taken to deliver it? For he surely would be less fortunate and possibly weaker physically than another who could have delivered the same in half the time. No, we should prefer to pay for it by the bushel. Why? Because it is cheaper, would you say? Not necessarily, but because it is more definite. It is a more business-like transaction.

And it is this characteristic that most strongly commends piece-work. So, treating labor as a commodity, it would furnish a similar example, and the only problem would seem to be in estimating the proper price to be paid for it. This can be accomplished with justice to both employer and employe, if each will be true to himself and both are honest with each other and will co-operate in the equitable adjustment of piece-work prices. There would be no occasion for fear or distrust if the workmen could be brought to understand that the companies do not desire to under-value their services nor to place prices too low, but that they do desire to reduce waste of time and energy by a systematic application of skill and labor such as this system affords. For here the company's interests becomes the workman's interests and vice versa, and the foreman experiences less anxiety as to how the workman may be putting in his time, for he feels assured that the men will utilize both their time and facilities to the best possible advantage.

In piece-work shops, the men are generally willing to concede that the system might be just, but they offer no objections upon other grounds.

First, and probably the most grievous, is that because of inexperience or lack of sufficient data, prices are set too low and the management may not be willing enough to readjust them.

Second, the material may vary in quality or conditions, so that the workman finds it impossible to duplicate the time—upon which the price was estimated—and fails on an average to accomplish the work in the required time. Or perhaps the amount of labor on a certain job may be increased by changes in the patterns or designs, without raising the price. All such things cause objections to arise, for which the system is not to blame, but may be due to local management or conditions that call for local investigation. In most places you will find the management fair, with a willingness to adjust matters satisfactorily to all concerned. But these and other common objections should be met fairly and the men satisfied, before they will be ready to acknowledge the justice of piece-work.

In order to successfully install the piece-work system into a shop it is important that the men should co-operate with the officials, and one of the greatest aids in this direction is in the inspector being a man of practical experience who is capable of placing a fair estimate upon the amount of labor and its value, and can win the confidence and respect of the workmen, who should rather regard him as a mediator than a scaler of prices.

Some men experiment with prices upon the theory that it is easier to raise a price than to lower one. This may be true in a sense, but the trouble is that usually even the best prices look very small to a day workman. So until the system becomes well founded and the workmen learn what is possible, and are better able to estimate the value of labor on a job, I believe it is preferable to risk over-paying rather than to pay too little, which discourages effort and enterprise.

(To be continued.)

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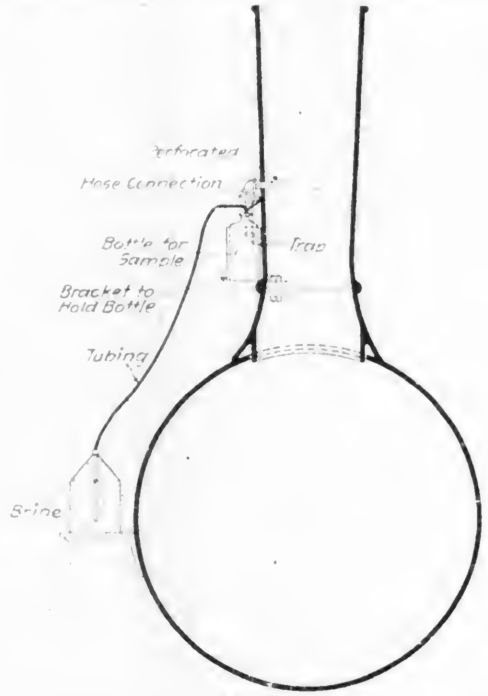

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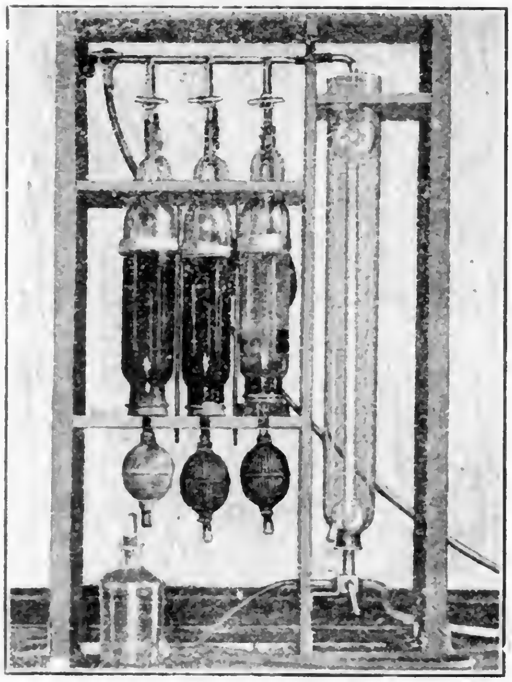

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Let us suppose that two young men of equal ability and like prospects should start to learn a trade and one should diligently apply all his energy, studying at night, working every hour he is able and faithfully striving to become a master of his profession, while the other is impatiently looking forward to the day when his term of apprenticeship shall have expired, seeking diversion at night, neglecting his duty by day, remaining off duty upon the least provocation, as some I have seen do, seeming to think that time is all that is necessary to serve in learning a trade and forgetting that practice alone can develop skill. At the expiration of their apprenticeship, which of these two young men would be the more competent workman and whose services would be worth the more? Naturally, we would answer that the faithful and most intelligent workman will accomplish the most and best work in a given time and his services be worth the most money, not alone for the amount of work done but for the quality as well, while the other fellow you will find to be the one who will do the most kicking against the piece-work system.

There are, however, many conditions to be considered in the successful introduction and practice of the piece-work system. A Chicago paper, in commenting upon this subject recently, mentioned as an objectionable feature, the unfair advantage it gives to unscrupulous and dishonest foremen who may, if they choose, materially affect the pay of any workman by the assignment of work. Certainly the charge that any foreman or minor official does, through personal feeling, make such use of the authority vested in him should be sufficient to disqualify him, but fortunately such cases are the exceptions and not the rule. So this objection should merely serve to warn us against such persons and bears no weight whatever against the system.

Then, some argue that it discriminates against the weak and less fortunate workman. Labor is often spoken of as a commodity as much as the corn that is sold by the farmer who, by the way, is a piece-worker in the extreme sense of the term, for he must provide his own tools, machinery, material and all facilities and then sell his produce by measure; then the man who lives farthest from the market or has the least facilities for delivering would require the most time in delivering a given amount of corn, for instance, but would we be willing to pay for it according to time taken to deliver it? For he surely would be less fortunate and possibly weaker physically than another who could have delivered the same in half the time. No, we should prefer to pay for it by the bushel. Why? Because it is cheaper, would you say? Not necessarily, but because it is more definite. It is a more business-like transaction.

And it is this characteristic that most strongly commends piece-work. So, treating labor as a commodity, it would furnish a similar example, and the only problem would seem to be in estimating the proper price to be paid for it. This can be accomplished with justice to both employer and employe, if each will be true to himself and both are honest with each other and will co-operate in the equitable adjustment of piece-work prices. There would be no occasion for fear or distrust if the workmen could be brought to understand that the companies do not desire to under-value their services nor to place prices too low, but that they do desire to reduce waste of time and energy by a systematic application of skill and labor such as this system affords. For here the company's interests becomes the workman's interests and vice versa, and the foreman experiences less anxiety as to how the workman may be putting in his time, for he feels assured that the men will utilize both their time and facilities to the best possible advantage.

In piece-work shops, the men are generally willing to concede that the system might be just, but they offer no objections upon other grounds.

First, and probably the most grievous, is that because of inexperience or lack of sufficient data, prices are set too low and the management may not be willing enough to readjust them.

Second, the material may vary in quality or conditions, so that the workman finds it impossible to duplicate the time—upon which the price was estimated—and fails on an average to accomplish the work in the required time. Or perhaps the amount of labor on a certain job may be increased by changes in the patterns or designs, without raising the price. All such things cause objections to arise, for which the system is not to blame, but may be due to local management or conditions that call for local investigation. In most places you will find the management fair, with a willingness to adjust matters satisfactorily to all concerned. But these and other common objections should be met fairly and the men satisfied, before they will be ready to acknowledge the justice of piece-work.

In order to successfully install the piece-work system into a shop it is important that the men should co-operate with the officials, and one of the greatest aids in this direction is in the inspector being a man of practical experience who is capable of placing a fair estimate upon the amount of labor and its value, and can win the confidence and respect of the workmen, who should rather regard him as a mediator than a scaler of prices.

Some men experiment with prices upon the theory that it is easier to raise a price than to lower one. This may be true in a sense, but the trouble is that usually even the best prices look very small to a day workman. So until the system becomes well founded and the workmen learn what is possible, and are better able to estimate the value of labor on a job, I believe it is preferable to risk over-paying rather than to pay too little, which discourages effort and enterprise.

(To be continued.)

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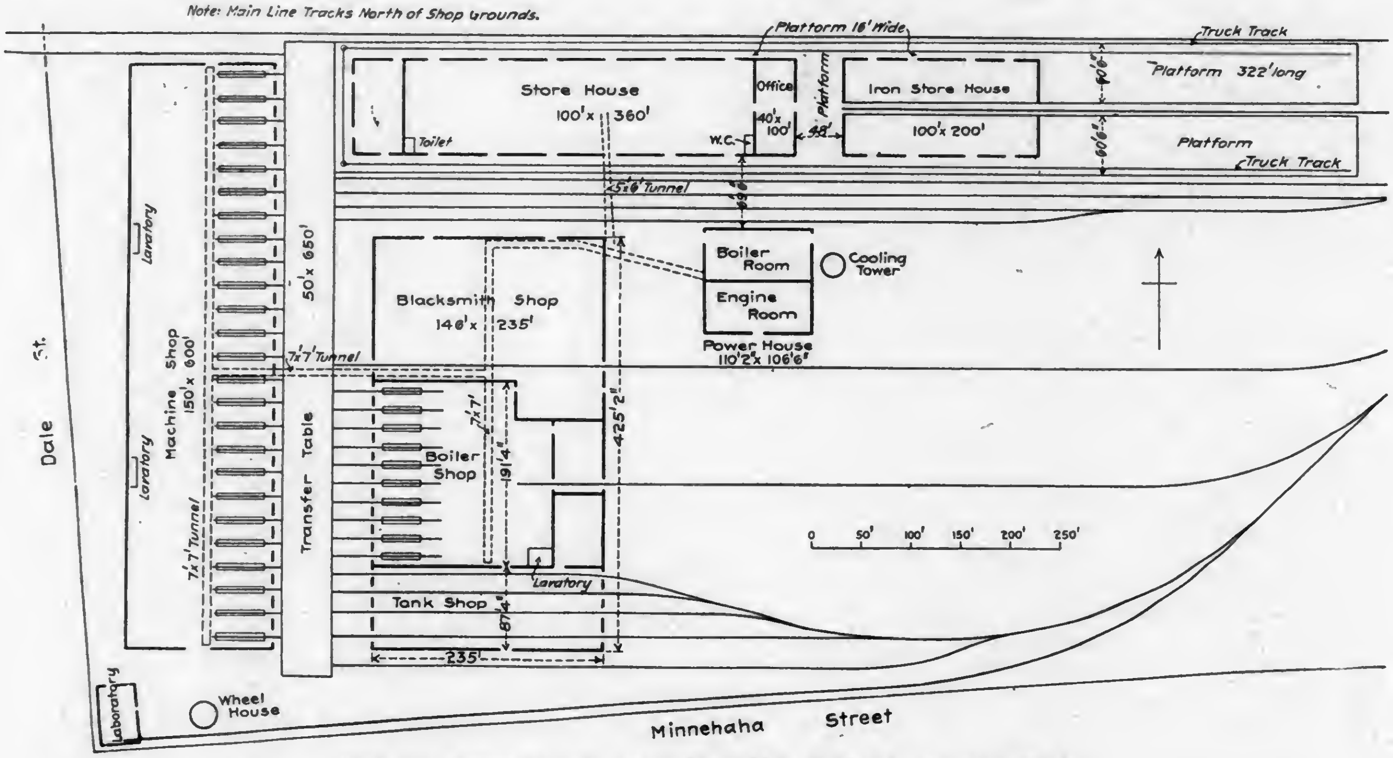

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It was found, in the design of the shop lay-out, that the cost of the feeder cables for the low voltage shop-power distribution would, by locating the plant opposite the center of power consumption, be reduced to one-fourth of that entailed by a location of the plant opposite one end of the machine shop. It was, at first, intended to locate the plant at the south end of the shop yard, but this was abandoned on account of the saving in copper in feeder cables with a central location.

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All the distribution wires leading to the locomotive-shop buildings are carried in underground tunnels or conduits, so as to present no obstructions and to be entirely protected. The wires for the distribution to the car shops, depot buildings, etc., are run on overhead pole lines at the higher voltage, the longest transmission being 9,000 ft.

The power generating equipment in the engine room consists of one 300-h. p. tandem and three 600-h. p. cross compound engines, all direct-connected to 2-phase, alternating-current generators, and one compound-steam, 2-stage air compressor. All the engines are operating non-condensing at present; they are so designed that one cylinder may be bushed down to permit operating condensing if found necessary, although the low price of coal, on account of the proximity of the mines, will undoubtedly make condensing an unnecessary elaboration.

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THE 50-KW. GENERAL ELECTRIC CO. EXCITER UNIT.

THE TWO-STAGE, CROSS-COMPOUND AIR COMPRESSOR.—INGERSOLL-SERGEANT DRILL COMPANY.

The engines driving the alternators are guaranteed not to vary in the angular velocity of their rotational motion more than 2 degrees per cycle of the current wave; this is necessary in order to avoid the irregularities in the alternating current wave, so detrimental to parallel operation. The foundations for the engines, generators, etc., are of slag concrete of very substantial shapes and rest upon bed rock. A free space is left in the engine room basement around the foundations which provides for the steam piping, both high-pressure and exhaust, and the auxiliaries, such as the boiler-feed pumps, etc. This not only frees the engine room floor from all obstructions, but permits free crane movements and adds a very neat appearance.

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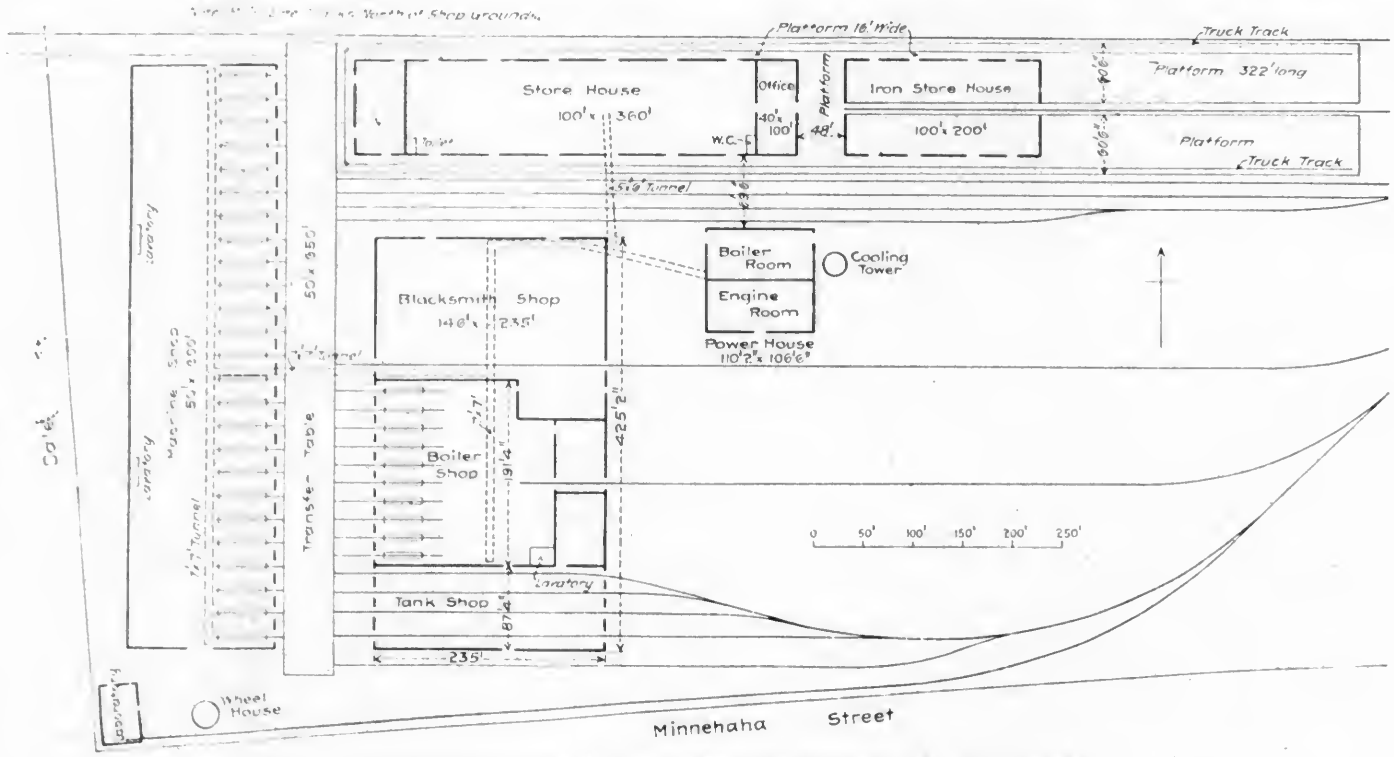

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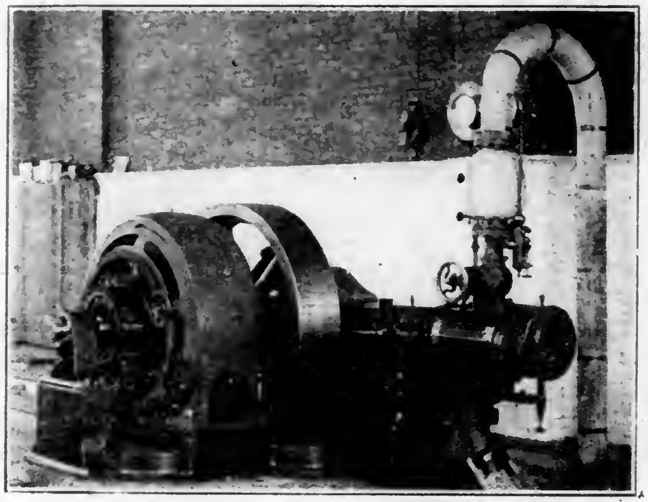

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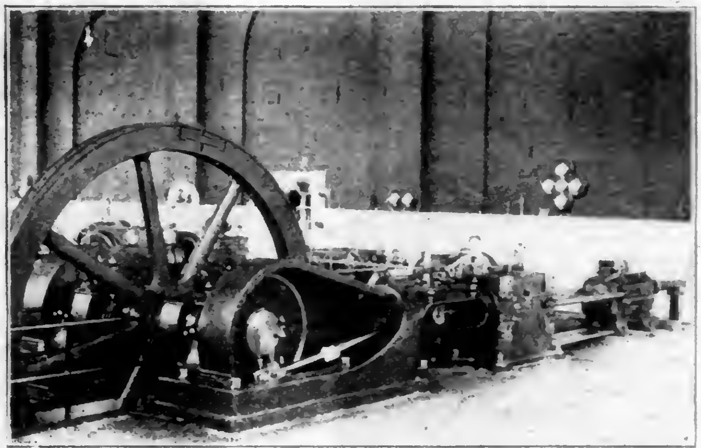

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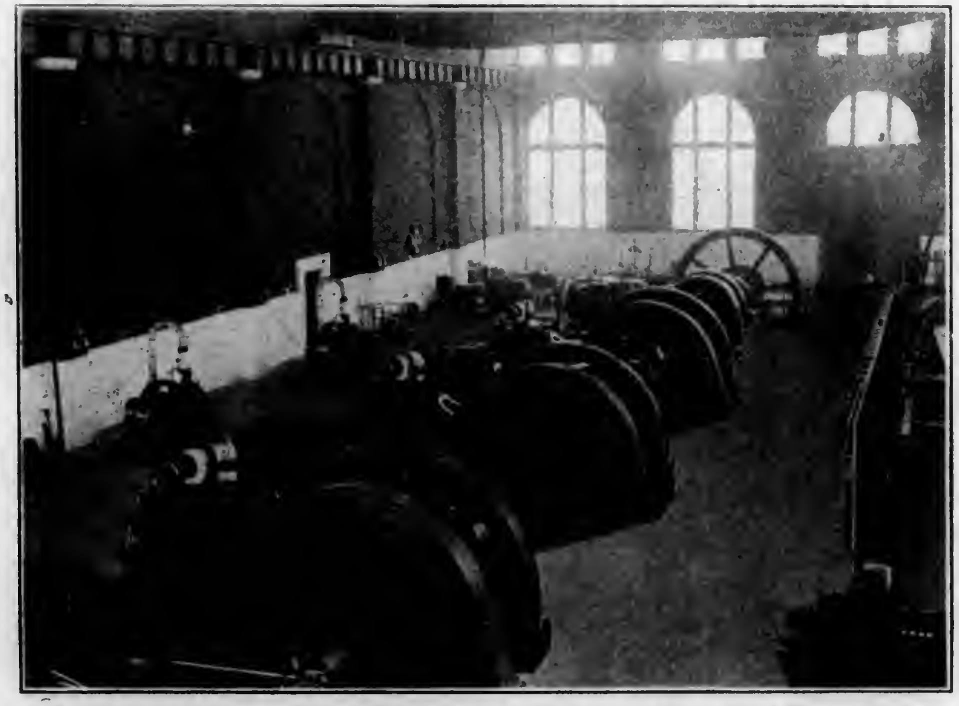
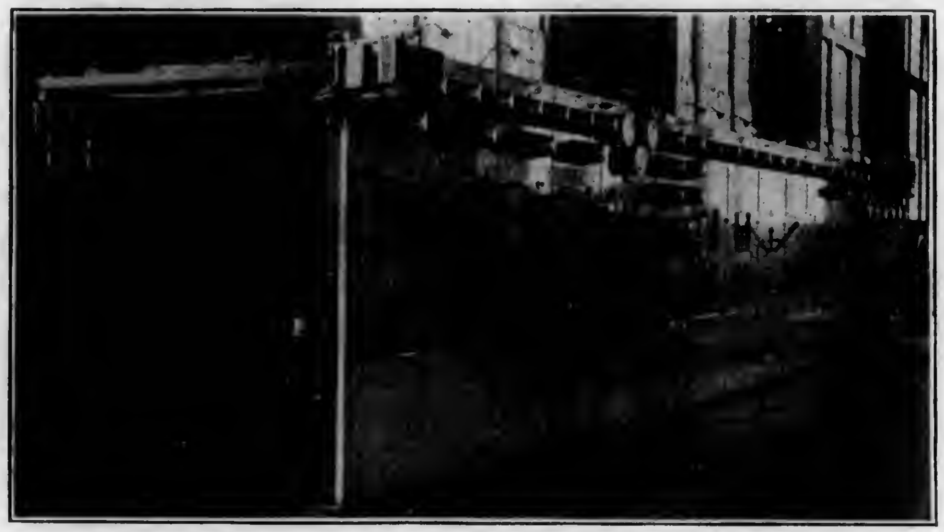


VIEW OF ENGINE-ROOM FROM NORTHWEST CORNER, SHOWING GENERATOR AND EXCITER UNITS.

VIEW OF ENGINE-ROOM FROM NORTHEAST CORNER, SHOWING ENGINES AND SWITCHBOARDS.

THE 400-KW. GENERAL ELECTRIC TWO-PHASE GENERATOR UNIT.—600-H.P. M'INTOSH & SEYMOUR ENGINE.



VIEW OF MAIN SWITCHBOARD (B) FOR THE SHOP DISTRIBUTION CIRCUITS. GENERAL ELECTRIC CO.

READING SHOPS POWER PLANT.—PHILADELPHIA & READING RAILWAY.

S. F. PRINCE, JR., *Superintendent Motive Power.* E. E. BROWN, *Electrical Engineer.*

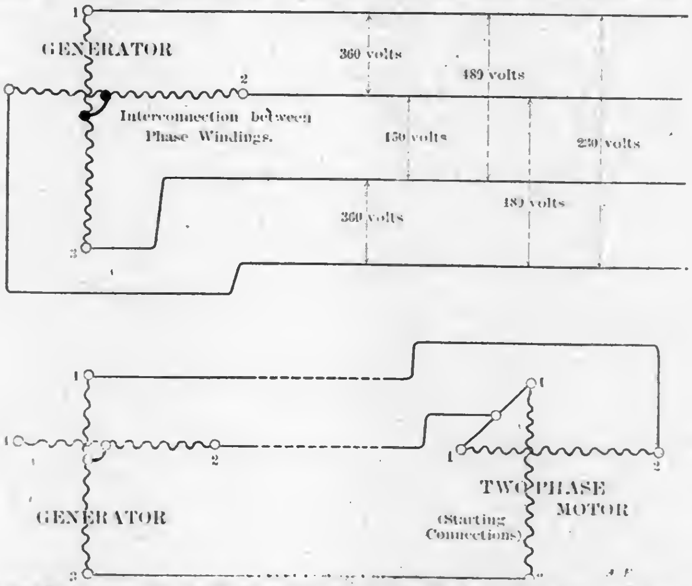
header in the boiler room basement, which delivers it either through a 24-in. pipe to the atmosphere or through a 20-in. steam heating main to the shop buildings. Connections are so made that either all or part of the exhaust may go to the heating system, the atmospheric connection being automatically controlled by a back-pressure relief valve. The exhaust passes through a 2,000-h. p. capacity Cochrane "open" feed-water heater and purifier.

The main alternators are of the stationary armature type, wound to deliver two-phase alternating current at 60 cycles, and are specially arranged for parallel operation. The engine speed of all four units may be adjusted from the switchboard for

THE 150-K.W. ROTARY CONVERTORS SUPPLYING THE CRANE AND OTHER DIRECT-CURRENT MOTORS.

synchronizing through the agency of a small series motor mounted upon each engine's governor, which changes the tension of the governor spring through worm gearing. In this way the alternators' fields may be brought up into synchronism by one person at the switchboard, thus eliminating the necessity of another man adjusting the throttle.

The windings on each machine for the two different phases are inter-connected out of balance for the purpose of furnishing a range of different voltages between the four wires of



ARRANGEMENT OF INTERCONNECTION BETWEEN PHASE WINDINGS OF GENERATORS FOR OBTAINING DIFFERENT VOLTAGES FOR SYSTEM OF STARTING THE MOTORS.

the two-phase distribution system. This is done for the purpose of enabling the induction motors in the shops to be started without the starting compensators or auto-starters that would otherwise be necessary. The arrangement of interconnecting between the two windings is shown diagrammatically above, and the various voltages obtainable are indicated. The lower diagram shows the connections that are made between a motor and the current supp'y when starting the motor.

After the motor is brought up to speed the connections are changed to the normal running arrangement (1 to 1, 2 to 2, etc.), by means of a four-pole double-throw knife switch which permits either arrangement. Each switch, which is thus used for starting, is plainly labeled for the *starting* and *running* position, the special connections shown above being, of course, the starting position. No difficulty is experienced in starting motors under full load by this system up to 40 h.p., and all the complication and extra cost of the compensators is avoided. The operation in multiple of the generators is not affected by this simple arrangement of interconnecting the phase windings, which also entailed no extra first cost in the generators.

Two 150-k.w. rotary convertors are provided for furnishing direct current for the crane motors and the variable speed motors used upon machine tools. The two machines run in parallel on the direct-current end, delivering 250 volts, and have an equalizer connection to the secondaries of the pair of static 90-k.w. transformers supplying the alternating current side, by means of which is formed a three-wire system giving 125 and 250 volts. The sketch below shows the arrange-

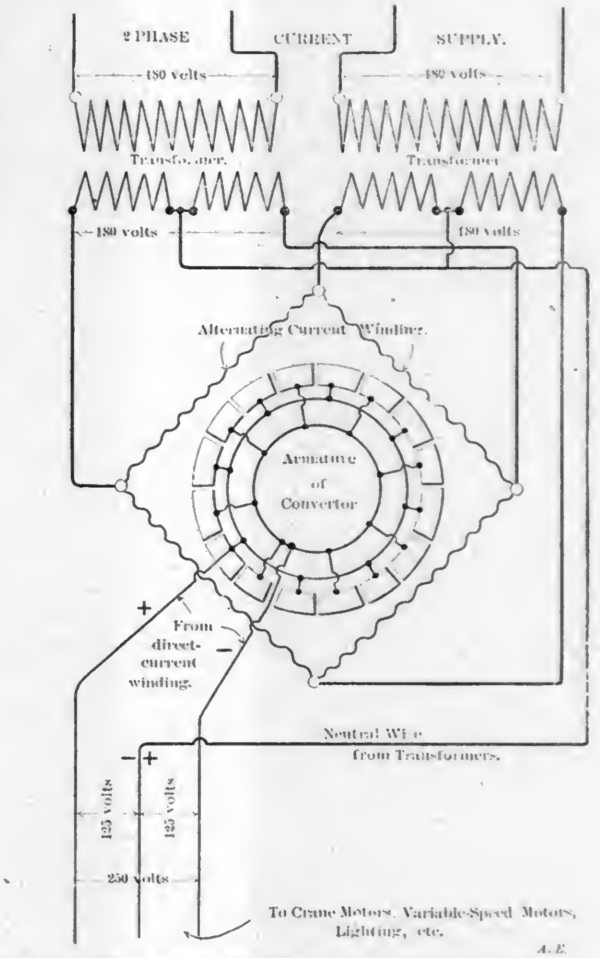


DIAGRAM SHOWING ARRANGEMENT OF ROTARY CONVERTOR AND TRANSFORMER CONNECTIONS FOR TWO VOLTAGES.

ment of connections for this service; the neutral wire of the three-wire direct-current system leads directly from the neutral points of the secondary windings of the pair of transformers. The motor ends of the converters are governed by induction regulators, by which the speed may be raised or lowered 5 per cent. from normal. The direct current ends are compound-wound, having equalizer connections, and maintain the voltage constant within 5 per cent. from no load to full load.

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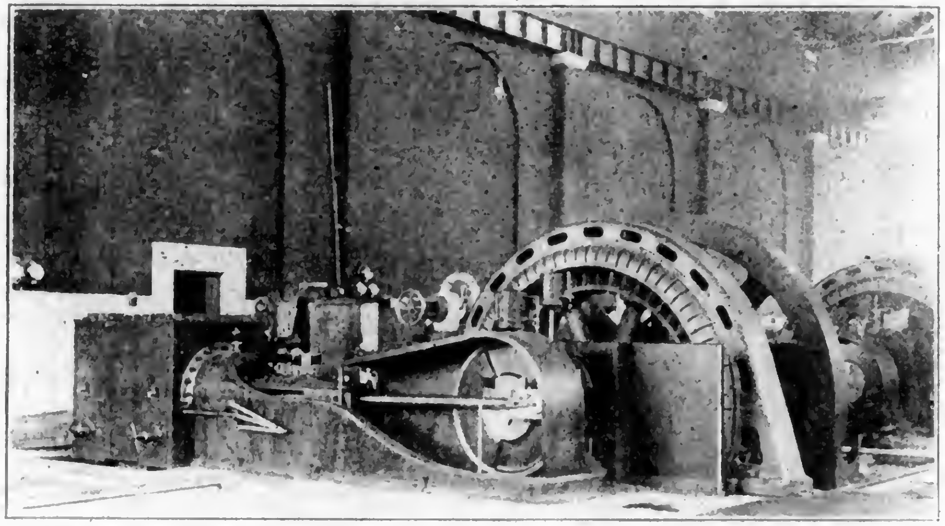
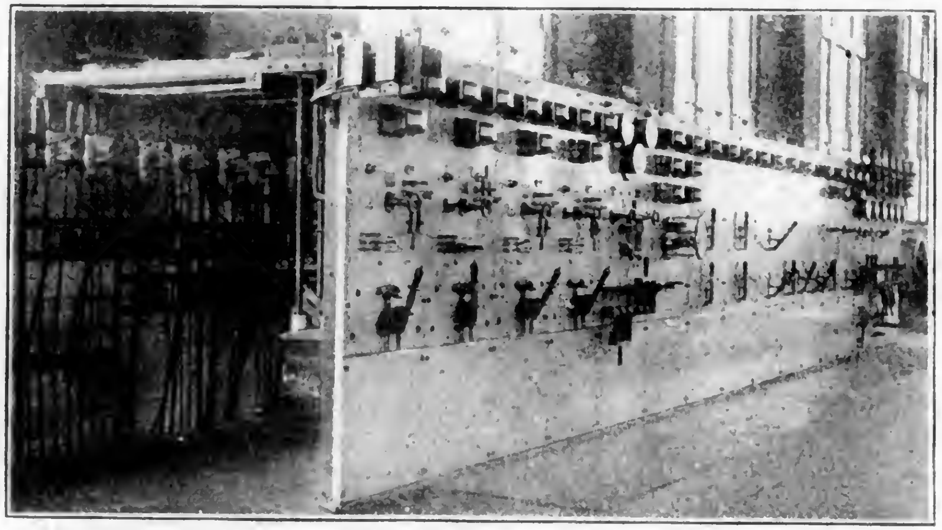
VIEW OF ENGINE-ROOM FROM NORTHWEST CORNER, SHOWING GENERATOR AND EXCITER UNITS.

VIEW OF ENGINE-ROOM FROM NORTHEAST CORNER, SHOWING ENGINES AND SWITCHBOARDS.



THE 400-KW. GENERAL ELECTRIC TWO-PHASE GENERATOR UNIT.—600-H.P. M'INTOSH & SEYMOUR ENGINE.



VIEW OF MAIN SWITCHBOARD USED FOR THE SHOP DISTRIBUTION CIRCUITS. GENERAL ELECTRIC CO.

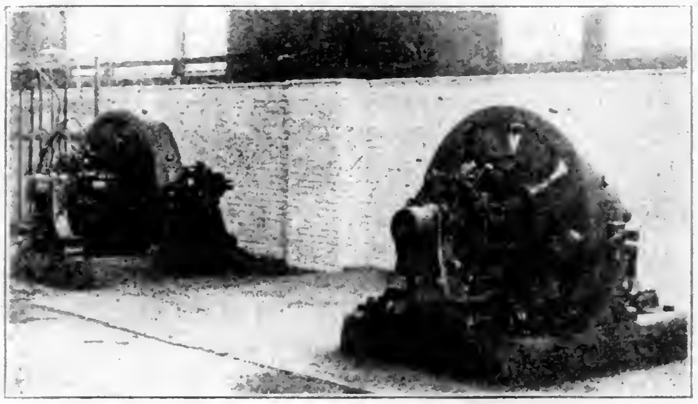
READING SHOPS POWER PLANT—PHILADELPHIA & READING RAILWAY

S. F. PRINCE, JR., *Superintendent Motive Power*

E. E. BROWN, *Electrical Engineer*

header in the boiler room basement, which delivers it either through a 24-in. pipe to the atmosphere or through a 20-in. steam heating main to the shop buildings. Connections are so made that either all or part of the exhaust may go to the heating system, the atmospheric connection being automatically controlled by a back-pressure relief valve. The exhaust passes through a 2,000-h. p. capacity Cochrane "open" feed-water heater and purifier.

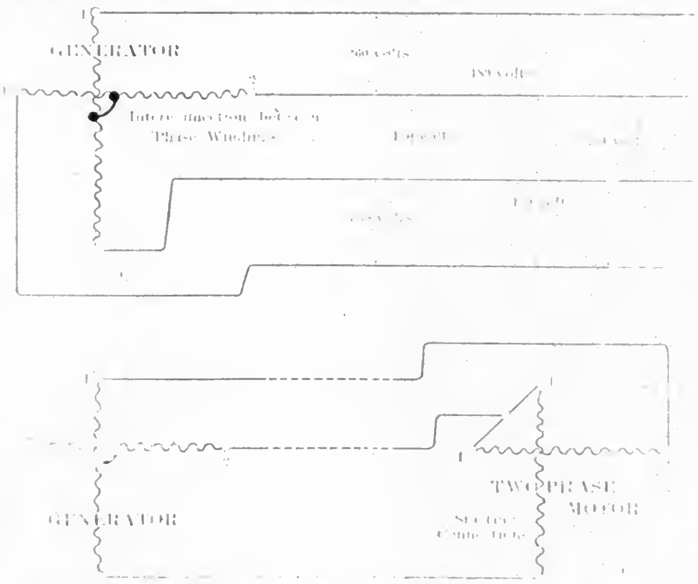
The main alternators are of the stationary armature type, wound to deliver two-phase alternating current at 60 cycles, and are specially arranged for parallel operation. The engine speed of all four units may be adjusted from the switchboard for



THE 150-K.W. ROTARY CONVERTORS SUPPLYING THE CRANE AND OTHER DIRECT-CURRENT MOTORS.

synchronizing through the agency of a small series motor mounted upon each engine's governor, which changes the tension of the governor spring through worm gearing. In this way the alternators' fields may be brought up into synchronism by one person at the switchboard, thus eliminating the necessity of another man adjusting the throttle.

The windings on each machine for the two different phases are inter-connected out of balance for the purpose of furnishing a range of different voltages between the four wires of

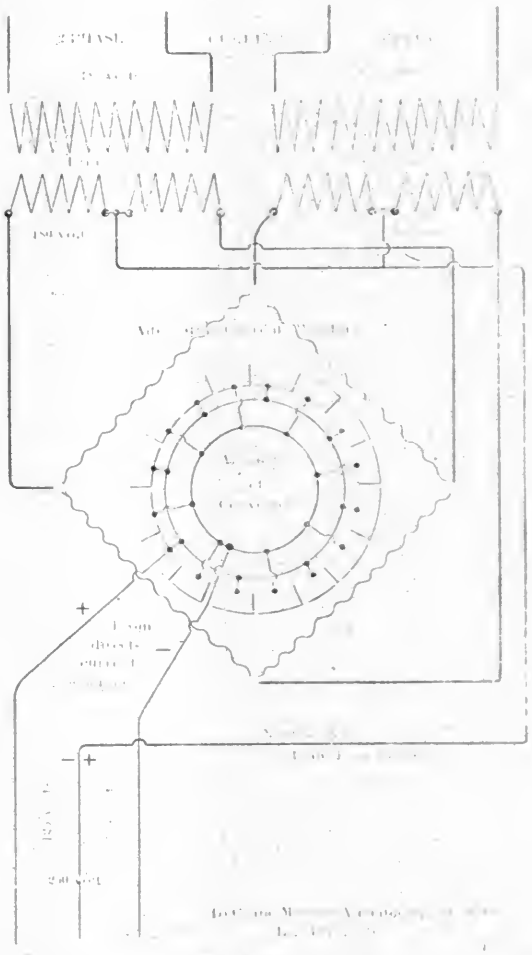


ARRANGEMENT OF INTERCONNECTION BETWEEN PHASE WINDINGS OF GENERATORS FOR OBTAINING DIFFERENT VOLTAGES FOR SYSTEM OF STARTING THE MOTORS.

the two-phase distribution system. This is done for the purpose of enabling the induction motors in the shops to be started without the starting compensators or auto-starters that would otherwise be necessary. The arrangement of interconnecting between the two windings is shown diagrammatically above, and the various voltages obtainable are indicated. The lower diagram shows the connections that are made between a motor and the current supply when starting the motor.

After the motor is brought up to speed the connections are changed to the normal running arrangement (1 to 1, 2 to 2, etc.), by means of a four-pole double-throw knife switch which permits either arrangement. Each switch, which is thus used for starting, is plainly labeled for the *start on* and *running* position, the special connections shown above being, of course, the starting position. No difficulty is experienced in starting motors under full load by this system up to 10 h.p., and all the complication and extra cost of the compensators is avoided. The operation in multiple of the generators is not affected by this simple arrangement of inter-connecting the phase windings, which also entailed no extra first cost in the generators.

Two 150-k.w. rotary convertors are provided for furnishing direct current for the crane motors and the variable speed motors used upon machine tools. The two machines run in parallel on the direct-current end, delivering 250 volts, and have an equalizer connection to the secondaries of the pair of static 90-k.w. transformers supplying the alternating current side, by means of which is formed a three-wire system giving 125 and 250 volts. The sketch below shows the arrange-



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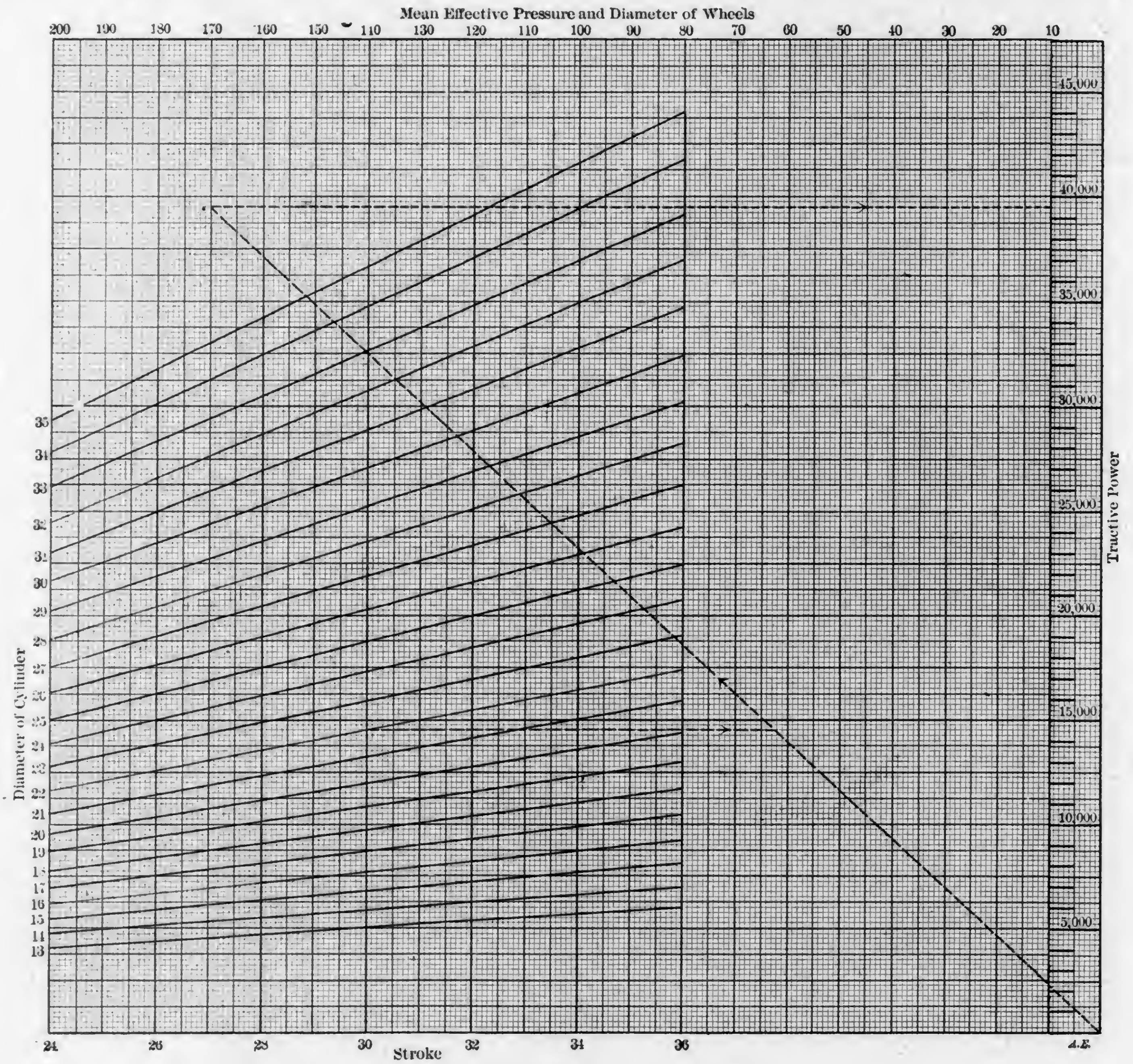
effects of electric storms are grouped on board A, where sufficient lightning-arrester protection is provided. The shop and underground distribution circuits, which are not exposed

SWITCHBOARD (A), CONTROLLING ALL OUTSIDE CIRCUITS, AND THE SERIES TRANSFORMERS FOR THE ARC-LIGHT CIRCUITS.

to lightning, are all controlled from board B. The switchboards, illustrated on pages 236 and 238, are both very attractive marble boards, erected upon metal framework, and were also furnished by the General Electric Company. They are located 8 ft. from the wall and there are 18-in. openings through the floor behind to accommodate the feeder cables from the engines and to the tunnel, all of which are carried in the basement. All the alternating-current circuits are controlled by oil switches.

Behind board A are located six of the new type of General Electric series transformers delivering constant-current at 6.6 amperes, for the series-alternating arc light circuits. Each transformer has a capacity of 50 arc lights, operated in two circuits of 25 each, and is insulated with oil. The total capacity of the transformers, 300 lights, will be distributed for lighting the yards of the entire properties of the company at Reading.

The distribution circuits are all led out from the switchboards underground through lead-covered cables, either to the shops or to the outlet to the overhead lines. An important feature of the distribution system is that, wherever located throughout the shops, all low-voltage wires are carried upon porcelain and the high-voltage wires upon glass insulators well up out of the way. This informs the workman at a glance which wires are to be avoided for safety.



A TRACTIVE POWER CHART.—BY L. L. BENTLEY.

NOTE.—The dotted lines show the method applied to the 2-8-0 C., R. I. & P. locomotive (AMERICAN ENGINEER, March, 1903, page 106). Cylinders 22 by 30 ins., driving wheels 63 ins., steam pressure 200 lbs.

CHART FOR TRACTIVE POWER OF LOCOMOTIVES.

BY L. L. BENTLEY.

While the general principle on which this diagram is constructed is not new, its convenience is such that it is hoped it may be of interest. In order that it may be reproduced a description of the construction is given.

Taking the usual formula for the tractive power of a simple engine

$$T.P. = \frac{p\,d^2 s}{D}$$

where T.P. = tractive power
p = mean effective pressure = a constant × boiler pressure,
d = diameter of cylinder in inches,
s = stroke in inches,
D = diameter of driving wheels in inches,
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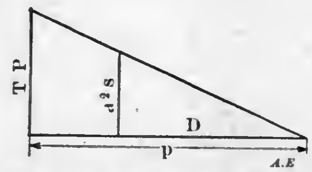
which can be expressed graphically by the sides of two similar triangles, as in figure.



The quantity, $d^2 s$, can evidently be expressed graphically by a straight line if we take s as the variable. Beginning at the left side of the diagram, the stroke (between the ordinary limits of 24 and 34 ins.) was laid off as abscissæ and ordinates erected the full height of the diagram. The units are:

$d^2 s$	1″ = 5,000 cu. in.
Tractive power	1″ = 5,000 lbs.
Mean effective pressure........	1″ = 20 lbs.
Wheel diameter	1″ = 20 in.

The value of $d^2 s$ were laid off on ordinate 24 to scale, and the same for ordinate 36, the corresponding points being joined by the inclined lines, the intersections with the stroke verticals giving the intermediate values of $d^2 s$. The tractive power scale was next laid off at the right and the driving wheel scale at the top. The fourth quantity, or mean effective pressure, was then found, the others having been assumed arbitrarily. This is done by substituting in the equation of the tractive power the values of 1 in. of scale. This coincides with that of the wheel diameter and is extended sufficiently to cover the necessary range.

The diagram is now complete with the origin in the lower right-hand corner. A thread attached at this point can be conveniently manipulated with the left hand and the course of the diagonal line traced without the necessity of drawing a line on the diagram.

To use the diagram find the diameter of the engine cylinder at the left, proceed along the inclined line to the intersection of the stroke vertical, thence along the horizontal to the intersection with the vertical representing the wheel diameter. Through this intersection draw a line to the origin and prolong it to intersect with the vertical representing the mean effective pressure. The tractive power is then read on the scale at the right.

For four-cylinder compound engines find the tractive power for the high-pressure cylinders and low-pressure cylinders separately from the diagram in the same manner as for simple engines. The sum of these results gives the total tractive power.

For two-cylinder compounds proceed as for four-cylinder engines and divide the result by two.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

REPORT BY PROFESSOR W. F. M. GOSS.

XVII.

(Continued from page 164.)

[EDITOR'S NOTE.—The conclusions reached by Professor Goss are advanced out of the regular order for the purpose of bringing his summary before our readers at the time of the Master Mechanics' Association convention. A statement of the status of the tests will be found on the editorial pages of this issue.]

SECTION VII.

A SUMMARY OF RESULTS.

48. The more important conclusions to be drawn from the results of the tests may be briefly stated as follows:

1. All portions of the smoke-box which are in front of the diaphragm have substantially the same pressure; and, consequently, a draft-gauge attached at any point may be depended upon to give a true reading (Article 15).

2. The resistance which is offered to the forward movement of the air and gases between the ash-pan and the stack, may be divided approximately into three equal parts which are, first, the grate and the coal upon the same; second, the tubes; and, third, the diaphragm. It is significant that the diaphragm is as much of an impediment to draft as the fire upon the grate (Article 16).

3. The form and proportions of the stack for best results are not required to be changed when the operating conditions of the engine are changed. That is, a stack which is suitable for one speed is good for all speeds, and a stack that is suitable for one cut-off is good for all cut-offs. In future experiments of draft appliances, therefore, results obtained from a single speed and a single cut-off should be deemed satisfactory (Article 38).

4. Other things remaining unchanged, the draft varies with the weight of steam exhausted per unit of time; if the number of pounds of steam exhausted per minute is doubled, the draft, as measured in inches of water, is doubled; if it is halved, the draft value is halved (Article 45).

5. As regards the form of outside stacks, either straight or tapered may be used. From a designer's point of view, the tapered is the more flexible; that is, with the tapered stack, the draft is less affected by slight departures from standard dimensions. Incidental reasons, therefore, make the tapered form preferable. For best results, the diameter of a given straight stack should be greater than the least diameter of a tapered stack for the same conditions.

The term "tapered stack" used in this and other paragraphs signifies a stack having its least diameter or "choke" 16½ ins. from the bottom, and a diameter above this point which increases at the rate of 2 ins. for each foot in length (Article 44).

6. In the case of outside stacks, either straight or tapered in form, the height is an important element. In general, the higher the stack, the better will be the draft (Article 43).

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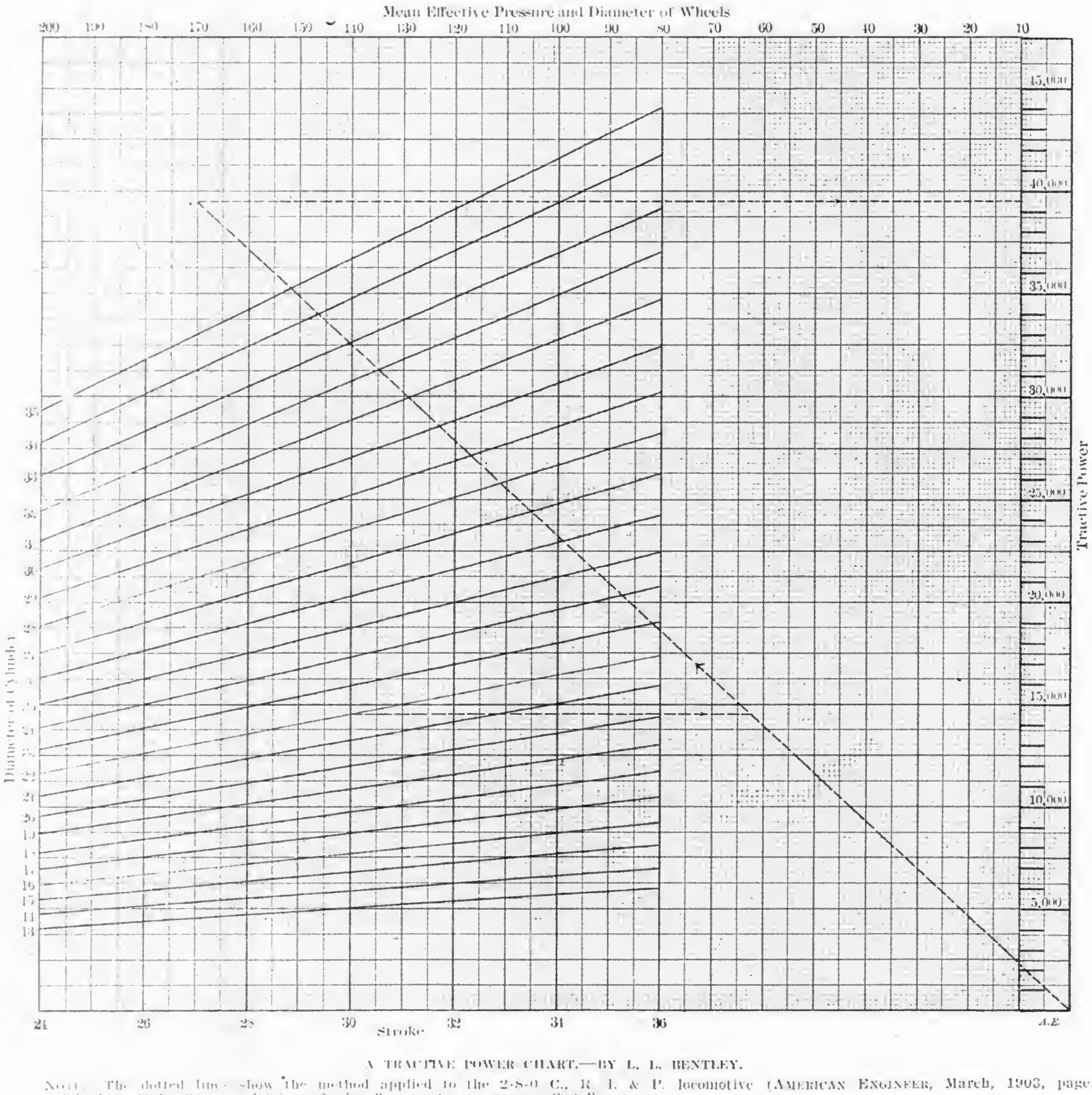

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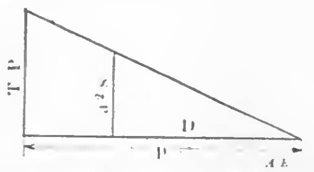

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8. The diameter of a straight stack designed for best results is affected by the height of the stack. As the stack height is increased, the diameter also must be increased (Article 40).

9. The diameter of a tapered stack designed for best results, as measured at the choke, is not required to be changed when the stack height is changed (Article 40).

10. The precise relation between the diameter of front end, and the diameter and height of stack for best results, is expressed by equations (Article 42) as follows:

FOR STRAIGHT STACKS.

When the exhaust nozzle is below the center line of the boiler,

$$d = (.246 + .00123\,H)D + .19\,h$$

When the exhaust nozzle is above the center line of the boiler,

$$d = (.246 + .00123\,H)D - .19\,h$$

When the exhaust nozzle is on the center line h is equal to zero and the last term disappears, and there remains,

$$d = (.246 + .00123\,H)\,D$$

FOR TAPERED STACKS.

When the nozzle is below the center line of the boiler,

$$d = .25\,D + .16\,h$$

When the nozzle is above the center line of the boiler,

$$d = .25\,D - .16\,h$$

When the nozzle is on the center line of the boiler, h becomes zero, and

$$d = .25\,D$$

In all of these equations, d is the diameter of the stack in inches. For tapered stacks, it is the least diameter or diameter of "choke." H is the height of stack in inches and for maximum efficiency should always be given as large a value as conditions will admit. D is the diameter of the front end of the boiler in inches, and h the distance between center line of boiler and the top of the exhaust tip.

Section VIII.

49. *Problems for Further Study.*—The Chicago & Northwestern experiments (Master Mechanics' Association Proceedings, 1896) settled all questions relative to the form of the exhaust pipe and tip, and the American Engineer Tests, as described in this report, are equally conclusive concerning the proportions of an outside stack when used in combination with nozzles of different heights. When, therefore, designers are content to employ plain forms of construction, the whole problem of front-end design may be considered solved. But conditions have of late arisen which enforce the use of stacks so short that the best proportions which can be given them do not yield satisfactory results. As a consequence, practice now tends along new lines for which there is little data that can be of service to the designer. That this deficiency may be supplied, it is necessary that the plan of tests already followed be extended to include other forms of mechanism. This is the more desirable since the results desired are not likely to be forthcoming from the road but, on the contrary, can best be obtained from the laboratory. The fact, also, that a large amount of data which will serve as a base line from which efficiencies of other apparatus may be measured, has already been collected from the Purdue locomotive, and the fact, also, that the work already done suggests the elimination of certain variables and a corresponding reduction in the number of observations hitherto considered necessary, all suggest the desirability of continuing the investigation along the general lines of the American Engineer Tests. If this should be agreed upon, the work should, in the opinion of the undersigned, be made to include the following subjects:

a. *Inside Stacks*, by which is meant a stack of usual form, but which instead of being entirely above the smoke-box extends downward into the smoke-box as well as out through its top. Where conditions are such that the portion of the stack extending outside of the smoke-box is necessarily short, this arrangement is much used. The American Engineer Tests have already included some observations on a straight inside stack of a single diameter, but the results obtained are not sufficient to serve as a basis for general conclusions. That the required data may be obtained, it will be necessary to employ stacks of at least three different diameters, and each diameter should have three different degrees of penetration into the smoke-box. Some additional work, also, may need to be done to determine the best form of the lower portions of the stack. It will be sufficient to employ the tapered form of stack only, and to have the outside length of stack constant.

The application of these stacks of different sizes will involve some cutting of the smoke-box, and the change from one stack to another may make the progress of the work slow, and consequently, somewhat expensive, but the results will be worth the pains for there is no other way by which the desired information may be obtained.

b. *Draft Pipes in Connection with Outside Stacks.*—It has been suggested that a draft pipe, or a combination of draft pipes, may be accepted as a complete substitute for an inside stack, and many roads are using them, apparently with good results. The experiments should deal first with a single draft pipe which should be varied in diameter and vertical position until the best diameter and position can be definitely chosen. After this, the process should be repeated in connection with a double draft pipe. A comparison of results thus obtained, with those obtained from the outside stack without draft pipes, should disclose the value of the draft pipes, and similarly a comparison of results obtained with those given by the inside stack should show whether the draft pipes are to be preferred to the inside stacks.

c. *False Tops Within the Smoke-Box.*—A number of railroads are now following the practice of blanking off the upper part of the smoke-box in such a manner that a stack of ordinary form may start from a point which is lower than the top of the boiler. The arguments in favor of such an arrangement are to be found in the fact that while the stack has the character of an outside stack, it can be made of greater length than would otherwise be possible. Whether there is any loss of efficiency resulting from the reduced height of the smoke-box, and, if so, whether it equals or exceeds the gain resulting from the increased length of the stack, are important questions. To settle this, false tops of at least three different forms should be experimented with, in combination with stacks suitable for each form. A comparison of results with those obtained under the provisions of preceding paragraphs would show to what extent, if any, such an arrangement is superior to others which are more common.

d. *Diaphragm.* As is well known, the diaphragm is not common in foreign practice, while in American practice its presence greatly impedes the forward movement of the gases. For this reason it would be well if it could be wholly omitted. It remains, however, to be determined whether there is any combination of nozzle and stack which in its absence will give satisfactory draft and at the same time draw equally on all tubes. The undersigned is not prepared to outline in detail a series of tests which will settle this question, but he believes it to be of importance, and that the means to be employed will be apparent as the work outlined in the previous paragraphs proceeds.

With full information concerning the relative value of the inside stack, draft pipes, the false top and the diaphragm, and with data which will permit any of these to be at once so designed as to give maximum efficiency, the problem of the front end, so far as it can be seen at present, is solved. While work of this character can be started and advanced slowly at small cost, it would be well if it could be vigorously pushed. To do this it will be desirable to have both the laboratory and the computing room manned at the same time, and to have assigned to the work an expert of sufficient ability and leisure to insure the prompt handling of all experimental results. Money will also be needed to supply and attach the special equipment and to defray the usual running expenses of the laboratory. While, therefore, much might

be done at small cost if plenty of time were available, the best policy requires that there be available a sum of from five to seven thousand dollars, at least four thousand being available for the first year's work. Upon this basis the remaining problems of the front end could soon be definitely solved.

EDITORS' NOTE.—The conclusion of the report and the intervening portion of the record will be printed in a subsequent issue.

(To be continued.)

CORRESPONDENCE

A DEFENSE OF PISTON VALVES.

Topeka, Kansas.

To the Editors:

I have been intending to write you ever since I read the paper by Mr. Gaines about piston valves at the meeting of the New York Railroad Club, February 20. I think the position Mr. Gaines takes is entirely untenable, as the simplicity of the piston valve as compared with the complicated method of balancing slide valves, as referred to in his paper, would certainly entitle it to a great deal of respect, and particularly when we consider that the machine work on a piston valve needs to be anything but high grade, whereas the balanced valve requires very careful work and some parts are extremely difficult to make. I have always felt that the piston valve was easier on the link motion, and particularly when carefully designed.

We know that the piston valve can be readily handled with one hand in large engines, and this has been a great surprise to engineers when using these engines for the first time. There are several arrangements for overcoming water in cylinders, and the one used by the American Locomotive Company is, I believe, giving excellent results.

In regard to the wear of piston valves and slide valves, I must say that my experience has shown that piston valves wear very much better than slide valves. I have seen cases where slide valves of the balanced type had to be removed and the valve seats refaced once or twice a week when in fast passenger service.

I believe that the piston valve is the best valve known at the present time for distributing steam in locomotives, and the large number of engines with this type of valve now being built by the American Locomotive Company and other builders shows that it is held in high esteem. Another feature is that if the piston valve is properly designed to admit steam on the inside that there are practically no opportunities for leaks around the front end due to the valve construction, as only the stuffing box will be exposed to steam, and that to exhaust steam, and by arranging the by-pass valves as is now done by the American Locomotive Company and by dispensing with the steam chest and other parts which are likely to leak, we have very much less chance for leaking steam at the front end to interfere with the view of the engineer.

It is doubtful whether it is desirable to get the clearance down to such an amount as is mentioned, as the compression will be entirely too great if the clearance be made too small. In some tests made by the Chicago, Burlington & Quincy several years ago it was shown that there was about as much difference of friction between the ordinary balanced valve and a piston valve as there was between an unbalanced valve and the balanced slide valve, and I hope you will put in evidence some information that will help forestall the discredit which has apparently been put upon the piston valve at this meeting. Yours truly,

G. R. HENDERSON,
Supt. Motive Power,
Atchison, Topeka & Santa Fe Ry.

THE SPECIAL APPRENTICE.

To the Editors:

Having noticed your editorial on page 140 of your April number, I beg to make a few comments upon the subject.

In the first place, if you or anyone else will explain in a satisfactory manner why a special apprentice in railroad shops should hold his position and work toward that of superintendent of motive power on any road, you will find five better reasons why he should get out of his job just as quickly as he knows how.

In my own case, having had seven years in universities and technical schools of the higher rank, and after working for two corporations doing research work and designing, I have given engineering lines the "go-by" and am now taking up the line of machinery salesman. What is more, I did not leave research work because of any failures in that or in designing.

Incidentally, it may be said that special apprentice jobs were looked upon at school as a last-chance affair, as they never carry a living salary. The time is passing when young college-educated engineers can be kicked around like yellow dogs at half the wages of a dago helper.

F. H. LACY,
San Francisco, Cal.

GROUP DRIVING OF MACHINE TOOLS.

BY J. C. STEEN.

Group driving may be considered from two points of view, one being the rearranging of an old plant, the other being the installation of a new plant. While it may be conceded that the individual method of driving is the preferable one, and usually the method to be desired, yet there are many cases where it cannot be adopted for various reasons, such as the greater cost of the large number of comparatively small motors and accompanying controllers, switches, circuit-breakers, wiring, etc. Especially is this the case when motors must be attached to old tools, as usually the design of existing old machine tools is such as to render the attachment of motors somewhat difficult without making the affair look patchy.

Again, the time required to make the necessary changes upon existing machines for individual driving may be a factor determining upon a group drive. The necessary time of draughtsmen, patternmakers and machinists cannot be spared, for they are usually busy with other lines of work.

Most of the reasons that determine for group driving apply equally to a new plant or to rearranging an old one, as in the case of a new plant usually many of the old machines are brought forward and continued in use. In either case it will usually be found advantageous to arrange the machines into a large number of comparatively small groups rather than a few larger ones. By this plan the tools or machines for certain classes of work can be placed in the most convenient position with reference to the general shop arrangements without giving any attention to a primary or main driving line shaft. The method of driving all machines from one common line shaft is responsible for many badly arranged machine shops.

Anyone who has ever had to lay out a machine shop under the old method and afterward had to do the same work under the grouping system will appreciate the advantages of the latter. With a new plant one usually has opportunity for obtaining a better arrangement of machines or tools than when rearranging an old one. One thing should be kept in view, as it deserves more consideration than is usually given; that is, to make proper allowance in space for future additions of machines as far as possible. Without proper provision in space allowance for changes, that which may be in the beginning a good arrangement will be a bad one when additions become necessary.

The experience gained in equipping thus a certain new shop recently built may be of interest. The question of power naturally came to the front. Of course, an engine is used as the prime source of power, and a generator was to be placed for lighting and testing purposes.

The question then came up as to how best to drive the small-tool department. The shop in question is of the three-bay type. One side bay contains the large planers, boring machines, radial drills, etc., all of which machines are driven from the main engine-driven line shaft. The center bay is used for erecting purposes, being covered by traveling cranes. The small-tool department is located in the third bay.

When locating the tools in the latter department they were so placed that in the process of manufacture all parts worked upon could be carried from the material storeroom through the various machine operations and returned to the finished

stock storeroom with a minimum amount of handling. For this department the use of two lines of shafting was deemed advisable. To drive these two lines from the main line shaft on the opposite side of the shop would require a rope or belt drive across the end of the building to avoid interference with the traveling cranes, but the natural objections to long belts or ropes, with their attendant idlers, carriers, take-ups, etc., led to the decision to use electric motors for driving, one for each line shaft, in the small tool department.

To determine the power required at each line shaft, each machine was carefully considered with relation to the work done upon it. No fixed formula or rule for required power was followed throughout, but each machine was considered separately and a power value was assigned which was considered as the maximum amount to be needed under average conditions. The table given below presents a list of the various machines, together with the amount of estimated power required for each one. One line shaft, which we may call A, is 130 ft. long and has 19 tools connected, while the other, to be called B, is 100 ft. long and drives 12 tools.

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1	24-in. upright drill	2
1	Sensitive drill	½
1	No. 2 Universal grinder	4½
1	Jones & Lamson lathe	2
1	15-in. lathe	1
2	16-in. lathes	2
1	14-in. lathe	1
2	19-in. lathes, total	3
1	24-in. shaper	2
1	22-in. planer	3
1	Cutter grinder	1
1	Twist drill grinder	1
19	Total	31

Number of machines.	Line Shaft B. Type of Tool.	Estimated power required, horse power.
3	No. 4 plain milling machines, total	6
1	20-in. lever drill	1
1	20-in. chucking lathe	2
1	Jones & Lamson lathe	2
2	25-in. lathes, total	4
1	18-in. lathe	1¾
1	16-in. shaper	1¾
1	Cut-off saw	1
1	Centering machine	½
12	Total	20

These figures having been estimated as the maximum required, it was roughly assumed that at no time would more than half the maximum estimated power be required for the tools at once, and in case that this maximum should be exceeded, it would be for a short time only, so that the motors could readily take care of the excess load.

For line shaft A a new 15-h.p. motor was installed; this motor has a capacity of 15 h.p. at 750 rev. per min. For driving line shaft B, a machine which had been in use for several years as a generator was changed over to a 10-h.p. motor by altering the connections; it was speeded at 800 rev. per min. The speed of the line shafts is each 160 rev. per min.

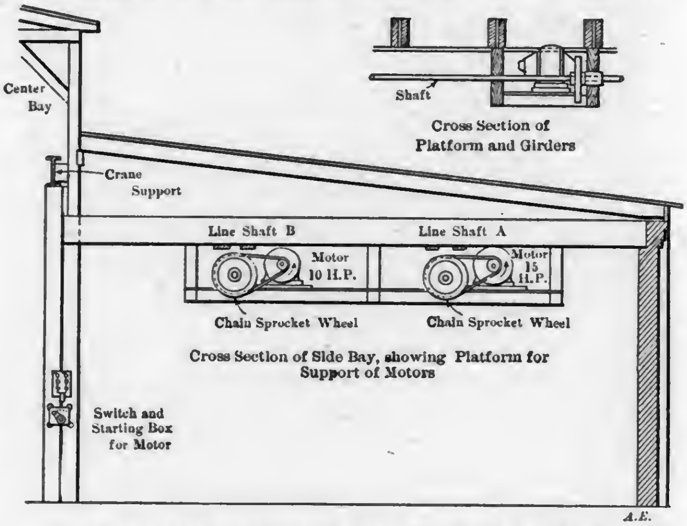
To avoid using belts, and to effect a compact arrangement, the motors were mounted upon a platform suspended from the overhead timbers, so as to come just below the line shafts, as shown in the cross-section of the side bay. The motors were connected to the shafts by Renold chains, being set as close to the line shafts as convenient. The switches and starting boxes were arranged upon opposite sides of a convenient column within easy reach of the floor, as shown.

It was found that the 10-h.p. machine would not run as fast when operated as a motor as its rated speed for use as a generator, but this was remedied by putting a small rheostat in the shunt field circuit.

So far the arrangement has proved quite satisfactory. Frequent observations of the current demanded by the motors by ammeter readings show that the power required for both lines varies from 15 h.p. to 22 h.p. (29 per cent. to 43 per cent. of the estimated maximum). It has shown as high as 25 h.p. (49 per cent.), but for a few moments only.

As an illustration of the capacity of a motor for taking care of an overload, it may be mentioned that owing to a slight accident the 15-h.p. motor was at one time disabled for about one day. When the accident occurred split pulleys of equal diameters were obtained, and both lines were thus coupled together and driven from the 10-h.p. motor. During the day the load averaged 18 to 20 h.p., sometimes going as high as 22 h.p. The motor carried the load all right, although it warmed up considerably while doing it.

This arrangement has some advantages. In case more machines are added and the motors become overloaded, it will be an easy matter to substitute a larger motor for the 15-h.p.



DRIVING ARRANGEMENT FOR THE GROUP LINE SHAFTS.

and the 15-h.p. for the 10-h.p., and use the 10-h.p. elsewhere. Or another method can be adopted: that is, to cut the line shafts up into two parts each and attach two more motors, thus having four group units instead of two. It has already been demonstrated in this installation that the advantage of being able to stop one group temporarily without interfering with the machines in the other group is one of no small importance.

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The rail and equipment department of the Walter A. Zelnicker Supply Company is represented by Mr. H. L. Schamberg with headquarters, for the present, at the Auditorium Hotel Annex, Chicago.

LINK-SLOTS AND PIN-HOLES IN M. C. B. KNUCKLES.

BY GODFREY W. RHODES.

ASSISTANT GENERAL SUPERINTENDENT, B. & M. R. R. R.

Has not the time come when the Master Car Builders' Association ought to make a vigorous move toward doing away with the link and pin slot and opening that now generally prevails in the M. C. B. knuckles?

The link and pin slot in the knuckle was one of the most serious weaknesses that confronted mechanical men in the introduction of the vertical plane coupler. Many will recollect the tirade that was made by the late A. M. Wellington in the *Railroad Gazette* in 1887 or 1888. He had visited the shops of the Chicago, Burlington & Quincy Railway Company at Aurora, Ill., where a collection of all the broken vertical plane couplers that were then being introduced, were kept. His emphatic summary was that the record was an "appalling one." Members of the association will well recollect that one of the most frequent causes of breakages were the top and bottom knuckle lugs. Efforts were made to strengthen these parts, not only with as much material as the adopted contour lines of the coupler would allow, but also in improving the material. Careful records were kept for a time. The breakages, however, still continued, although, perhaps in a less serious way, but the friends of the coupler all hoped for the day when the abandonment of links and pins from freight train service would make this weakness in the knuckles no longer necessary, as when links and pins are no longer used there will no longer be any necessity for dividing the top and bottom lugs of the knuckle by the link-slot, nor for coring out the hole of the knuckle for the pin.

BROKEN KNUCKLES DUE TO LINK SLOTS AND PIN HOLES.

The law requiring railroads to use automatic couplers was to have been put into effect January 1, 1898. This time was subsequently extended two years. Since January 1, 1900, it has been unlawful to use link and pin couplers in our trains. Notwithstanding the above facts, the railroads in this country are still using a divided knuckle, not only in freight train service, but actually in passenger train service. Has the time not come when we can safely make a move to do away with the old-time custom of link-slots in the knuckles and pin-holes through the knuckle? By doing this we will very materially increase, not only the surface wearing part of the knuckle, but also practically do away with broken lugs. While we do not hear as much about broken lugs as we did when the vertical plane coupler was first introduced, we have reason to believe that an investigation of the subject on any of the railroads in this country will show that they are still occurring with entirely too great frequency. In order to verify this the other day we went into the Lincoln, Neb., yards of the Burlington & Missouri River Railroad and looked up an accumulation of broken knuckles that had been turned in as scrap. The foreman in charge advised us that he had shipped away all his broken knuckles six weeks ago. We nevertheless went over the accumulation since that time and actually picked out 43 broken lugs. Attached you will find a photograph representing the lugs referred to.

There is nothing more serious or disastrous on a railroad than a break-in-two with a freight train. Every railroad has had experiences in this line that are more or less distressing, through the loss of life and damage to equipment and railroad property. Doubtless this photographic exhibition of 43 broken lugs represents break-in-twos that have been more or less disastrous. With a matter so easily remedied, ought we not to get right after it? By referring to the picture one knuckle will be observed intact for the purpose of illustrating the top and bottom lug. As a matter of fact even in this knuckle, the lugs had been broken and crushed out through the pin-hole, thereby further illustrating how this now unnecessary pin-hole weakens the knuckle lugs. Here is an economy that it seems to us all railroads should get after at once. Some already are taking steps in the matter, but there is nothing that will make it become general so quickly as a live discussion on the subject by the Master Car Builders at their annual convention.

An important point upon machine tools is the method of changing feeds. The old way of doing this, by altering the change wheels at the end of the lathe, is much too slow. We cannot spare the time in these days for the workman to pull out a roll of paper and figure out the necessary change wheels required to alter the rate of cutting by 1-16 in.—if the man is on day work his thoughts are rather apt to wander off, and if on piece work his appreciation of the tool maker is likely to be unfavorable. All changes of feed should be done by means of gears which can be altered by the simple movement of a lever. It may be thought that these points are embodied in all modern lathes; however, this is not so, as only recently lathes have been purchased from first-class makers that not only require the gearing to be changed to alter the rate of feed, but also necessitate a clumsy alteration of change wheels merely to change the direction of the feed.

"My experience with the gearing on most lathes is that the difference is much too great between the last single speed and the first geared speed. As an example, the speed on the slowest single speed is 80, and the quickest, with the back gear in, is 30. Now, this difference is much too great. I am aware that a few makers now manufacture lathes with an intermediate gear, but the practice is not common by any means. In my opinion you cannot have too many changes of speed, so long as they can be altered quickly.

"This point, moreover, calls attention to the method of changing the gear. Take such a simple circumstance as putting in the back gear. Why is it that one lathe has the eccentric movement and another the plain spindle which requires to be pushed in and pulled out? I know the arguments brought forward by the makers of the latter arrangement, viz., that it is the best for the gearing, but is this not again the old question of the *life of the tool* versus its *efficiency?* One objection that I have to the plain spindle is that the shaft carrying the back gear protrudes through the headstock and necessitates that the face plate should be carried further away from the headstock. The eccentric is by far the quickest to operate, and if well made is, in my opinion, quite equal to the other."—A Large User of Machine Tools.

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To determine the power required at each line shaft, each machine was carefully considered with relation to the work done upon it. No fixed formula or rule for required power was followed throughout, but each machine was considered separately and a power value was assigned which was considered as the maximum amount to be needed under average conditions. The table given below presents a list of the various machines, together with the amount of estimated power required for each one. One line shaft, which we may call A, is 130 ft. long and has 19 tools connected, while the other, to be called B, is 100 ft. long and drives 12 tools.

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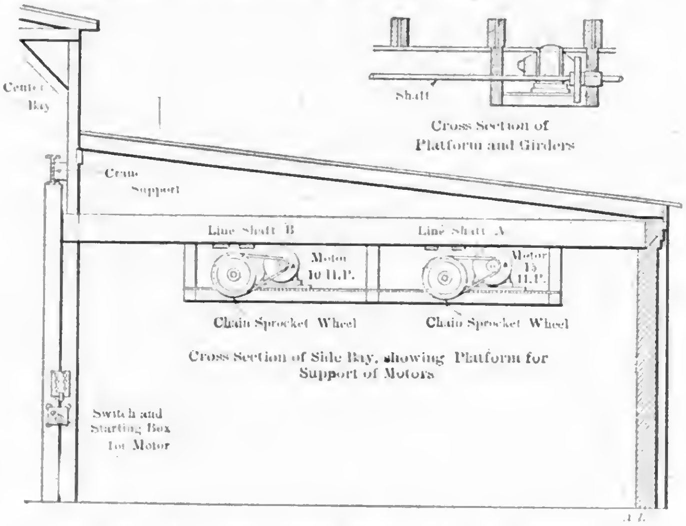

DRIVING ARRANGEMENT FOR THE GROUP LINE SHAFTS.

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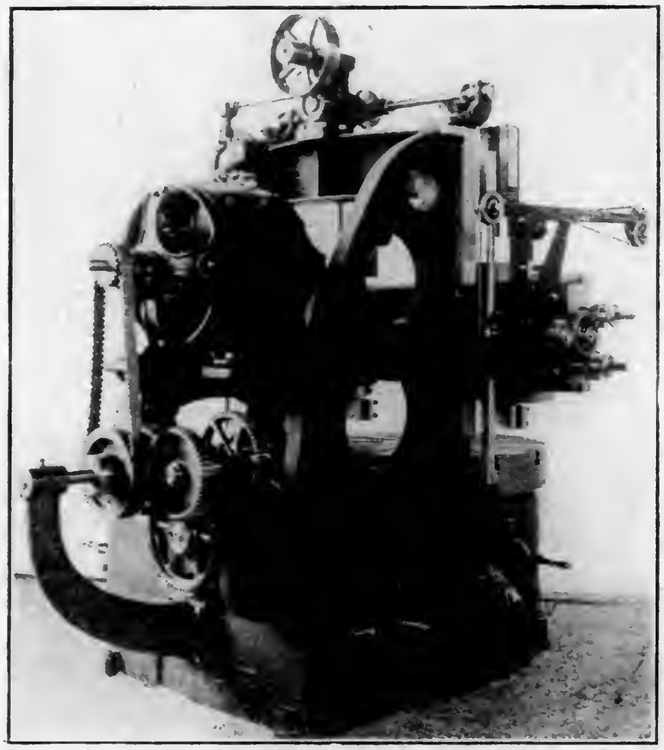
MOTOR DRIVEN MACHINE TOOLS.

EXAMPLES OF INDIVIDUAL DRIVES APPLIED TO BORING MILLS.

An important feature of the development of railroad machine shop practice is the greatly increasing use of the boring mill. The large number of machining operations in railroad repair work that can be handled on the boring mill to far better advantage than upon the lathe is the factor that has been effective in bringing it into very extensive use in railroad shops. In the locomotive machine shop alone of the Collinwood shops five boring mills have been installed, of the following sizes: two 84-in., one 54-in. and two 37-in., all of which are equipped for individual driving by electric motors.

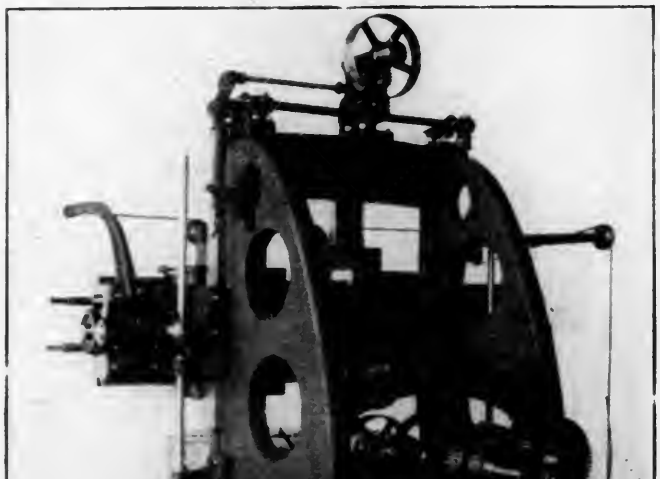
Accompanying this development has arisen the question as to the best method of driving. In all applications to railroad machine shop work they have been installed in sizes sufficiently large to warrant the application of individual motor drives. Also the individual drive furnishing variable speeds is particularly applicable to the boring mill on account of the widely varying classes of work to which it is adapted. The result is that a large number of excellent and very interesting motor drives have been installed upon tools of this type, with very satisfactory results. Below are presented some representative examples of such motor drives which will indicate the trend of progress in this direction.

The two engravings at the left illustrate an excellent arrangement of mounting a motor upon a boring mill. The machine shown is the 41-in. boring mill built by the Baush Machine Tool Company, Springfield, Mass., and is equipped with a 4-h.p. motor. The motor is mounted upon a neat bracket bolted in between the uprights of the machine's frame, at the rear, just above the main driving shaft. The drive is through a 1¾-in. Renold "silent" chain, delivering direct from the motor shaft to the driving shaft, and running at a velocity of from 600 to 1,200 ft. per minute. The speed reduction at the chain is very low, the driving sprocket having 23 teeth and the driven 30 teeth. The speed reduction is obtained by gearing between the driving shaft and the spindle.

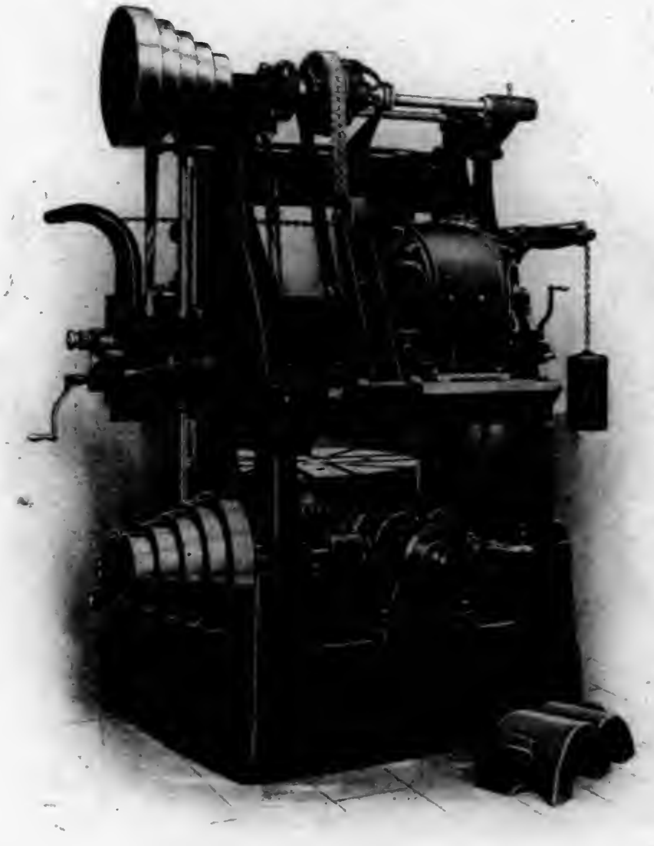


CHAIN DRIVE UPON A 41-IN. BORING MILL.—BAUSH MACHINE TOOL COMPANY.

FIELD CONTROL VARIABLE-SPEED MOTOR.—GENERAL ELECTRIC CO.



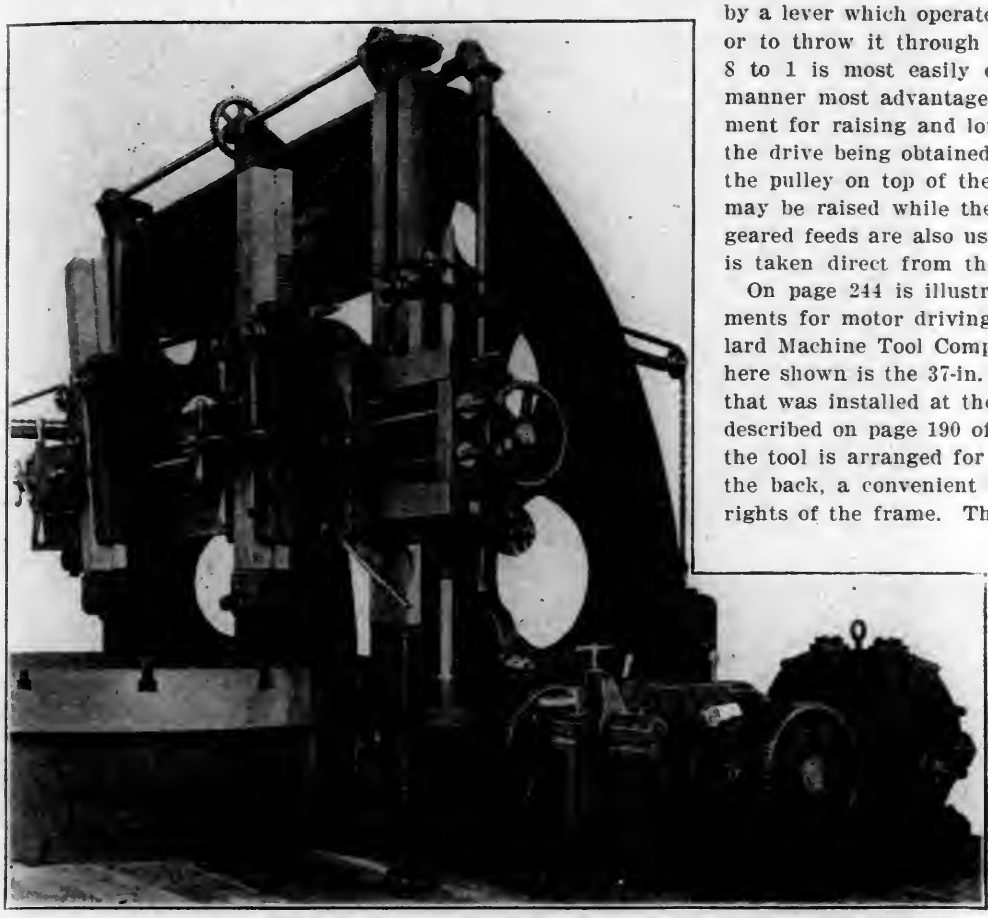
REAR VIEW OF THE 41-IN. BAUSH BORING MILL, SHOWING ARRANGEMENT OF BRACKET BETWEEN FRAMES FOR SUPPORTING MOTOR.



COMBINATION CHAIN AND COUNTERSHAFT DRIVE UPON A 37-IN. BORING MILL.—BULLARD MACHINE TOOL COMPANY.

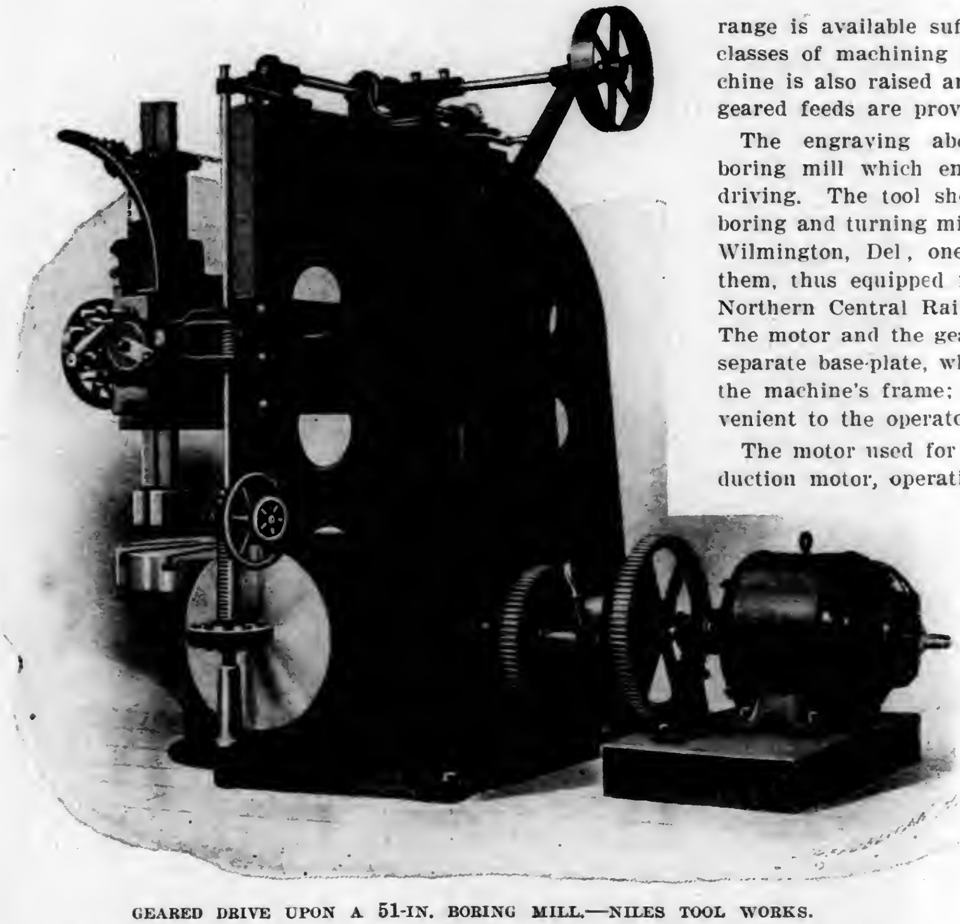
CONSTANT-SPEED GENERAL ELECTRIC MOTOR.

The motor is a 4-h.p. direct-current machine of the C-E type, made by the General Electric Company, Schenectady, N. Y., and has a 100-per cent. range (400 to 800 rev. per min.) by field regulation. Its rating of 4 h.p. is taken at its lowest speed—400 rev. per min. This speed range of 2 to 1 is quadrupled by two properly proportioned back-gear attachments arranged at the spindle as shown in the rear view at the left. The back-gear attachment is conveniently handled



GEARED DRIVE UPON AN 84-IN. BORING MILL, BUILT FOR THE PENNSYLVANIA RAILROAD BY THE BETTS MACHINE COMPANY.

10-H.P. INDUCTION MOTOR (CONSTANT SPEED).—WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.



GEARED DRIVE UPON A 51-IN. BORING MILL.—NILES TOOL WORKS.

MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC AND MANUFACTURING COMPANY.

by a lever which operates a clutch to connect the drive direct or to throw it through the gearing. Thus a speed range of 8 to 1 is most easily obtainable in small increments, in a manner most advantageous for the service. A power attachment for raising and lowering the cross-rail is also included, the drive being obtained by belting from the driving shaft to the pulley on top of the machine; in this way the cross-rail may be raised while the face-plate is at rest. Positive-drive geared feeds are also used upon this tool, the drive for which is taken direct from the spindle by spiral gearing.

On page 244 is illustrated one of the most recent arrangements for motor driving, which has been devised by the Bullard Machine Tool Company, Bridgeport, Conn. The machine here shown is the 37-in. Bullard boring mill, of the same type that was installed at the Collinwood shops, as illustrated and described on page 190 of our May (1903) issue. In this case the tool is arranged for mounting the motor self-contained at the back, a convenient bracket being bolted between the uprights of the frame. The drive is in this case also through a "silent" chain from the motor pinion direct to the countershaft, mounted at the top of the uprights. An idler pulley is provided to maintain the proper tension in the chain, which is not operated at a very high speed.

The motor used for this drive is a General Electric motor having a 100-per cent. speed range by field control. This is supplemented by a range of five different speeds, available from the cone pulleys and belt drive from the countershaft to the main drive shaft, and two additional speeds from the back-gear attachment on the spindle. This makes a very complete range of ten different speeds available, exclusive of those obtainable from the motor; thus, with the motor's range, a speed range is available sufficient to meet the requirements of all classes of machining operations. The cross-rail on this machine is also raised and lowered by power, and positive-drive geared feeds are provided.

The engraving above represents an individually-driven boring mill which embraces the very latest idea in motor driving. The tool shown is the 7-ft. improved worm-driven boring and turning mill built by the Betts Machine Company, Wilmington, Del, one of which was recently furnished by them, thus equipped for motor driving, to the shops of the Northern Central Railway at Mount Vernon, Baltimore, Md. The motor and the gearing for the drive are mounted upon a separate base-plate, which is bolted to the right-hand side of the machine's frame; in this way the gear-changes are convenient to the operator.

The motor used for this drive is a 10-h.p. Westinghouse induction motor, operating at a constant speed. The range of speed-changes which are so necessary for a tool of this type are obtained by means of a series of trains of gearing through which the motor drives the spindle of the machine.

This gearing arrangement consists of two gear-cones of four gears each mounted side by side, one of which cones is driven by the motor and the other is connected to the driving spindle of the tool. The two gear-cones are not in mesh with each other, being mounted permanently separated just out of mesh. Connection is made for driving across any particular step of

MOTOR DRIVEN MACHINE TOOLS.

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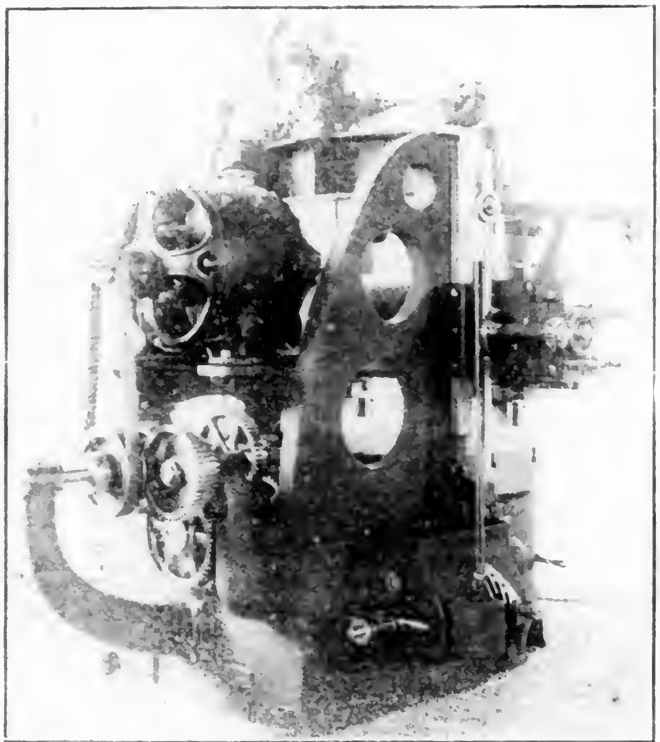
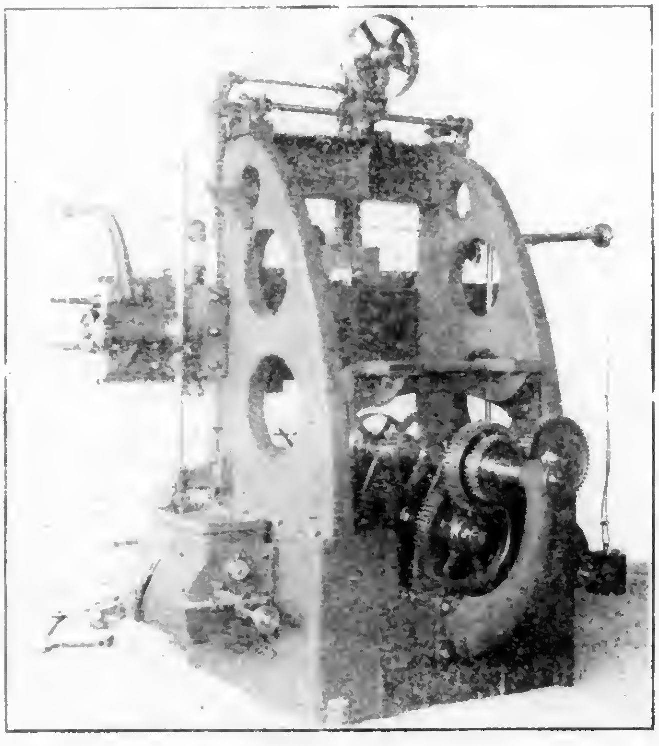


CHAIN DRIVE UPON A 41-IN. BORING MILL. BAUSH MACHINE TOOL COMPANY.

FIELD CONTROL VARIABLE SPEED MOTOR. GENERAL ELECTRIC CO.



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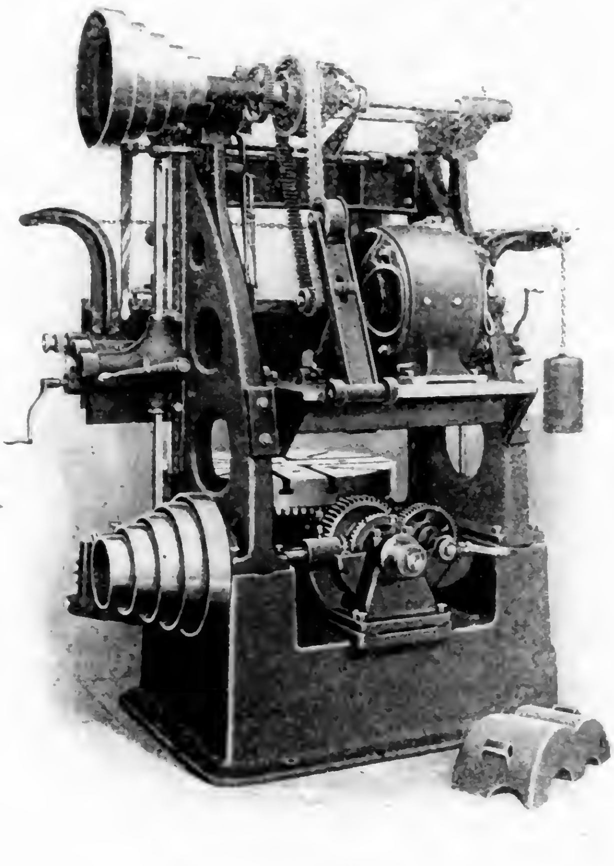

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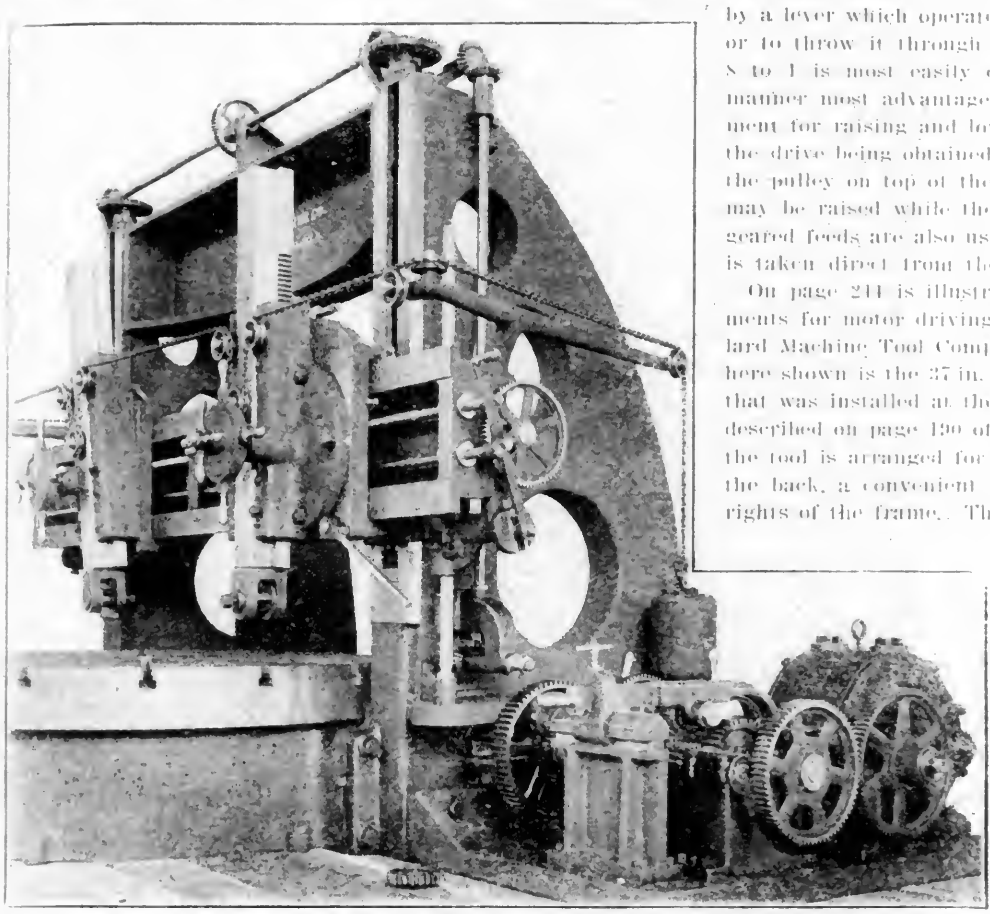

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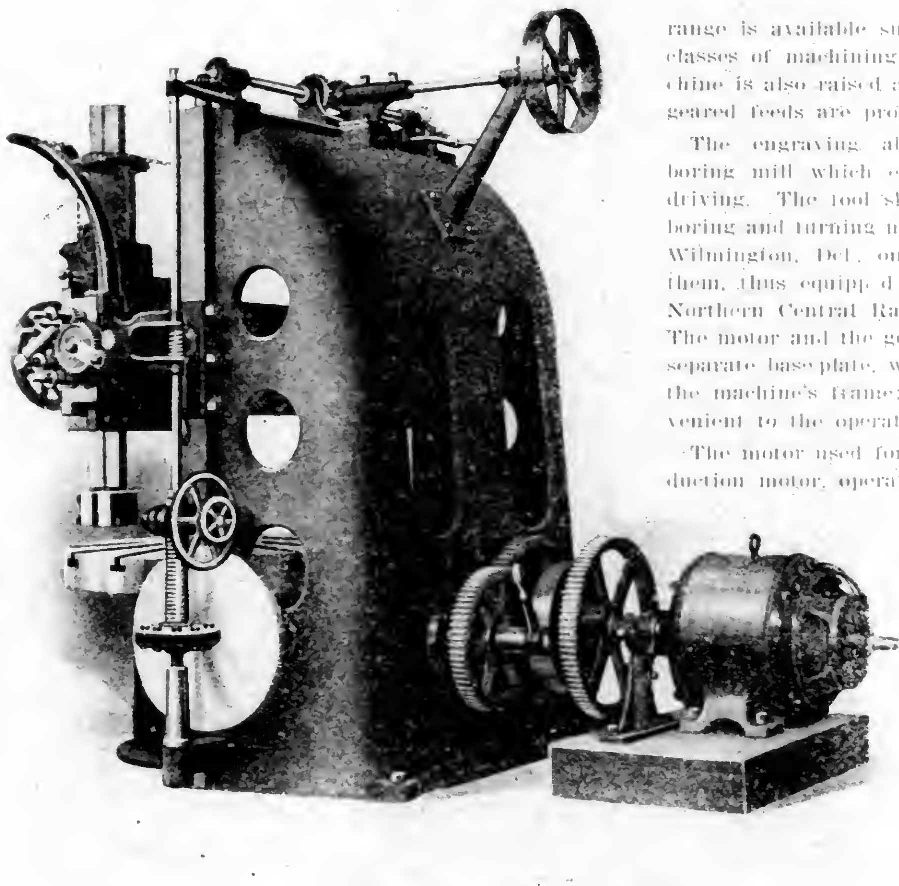
The motor used for this drive is a 10 h.p. Westinghouse induction motor, operating at a constant speed. The range of speed-changes which are so necessary for a tool of this type are obtained by means of a series of trains of gearing through which the motor drives the spindle of the machine.

This gearing arrangement consists of two gear-cones of four gears each mounted side by side, one of which cones is driven by the motor and the other is connected to the driving spindle of the tool. The two gear-cones are not in mesh with each other, being mounted permanently separated just out of mesh. Connection is made for driving across any particular step of



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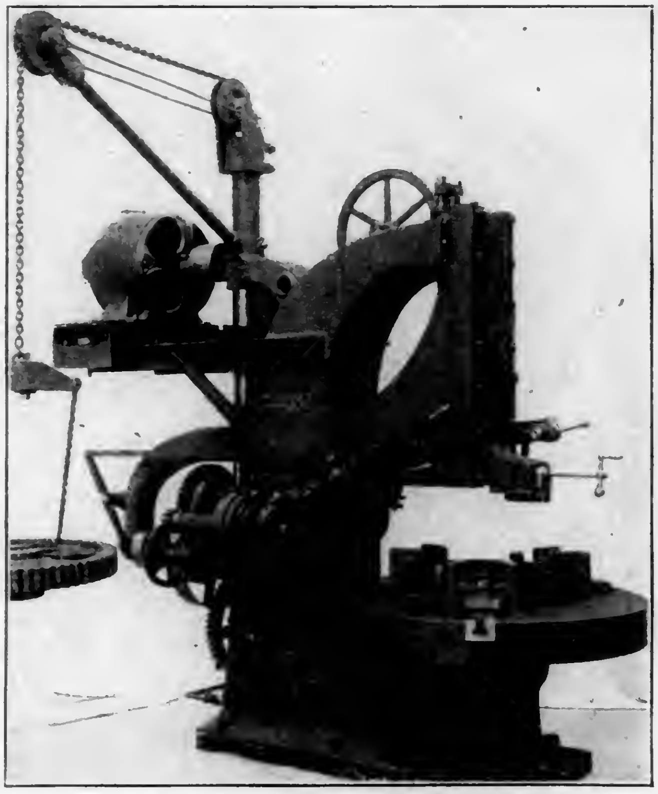
MULTIPLE-VOLTAGE MOTOR.—BULLOCK ELECTRIC AND MANUFACTURING COMPANY.

the cones by means of the pinion shown mounted upon the movable lever above the gearing; this lever is capable of motion in two different directions by means of the rocker shaft support at the rear, and may be held in mesh at any point by the clamp upon the support at the front. In driving the pinion is merely lowered in between the two gears of the step desired.

This is undoubtedly the newest gearing arrangement for motor driving that has been developed. It provides four different speeds, which, together with the four additional speed combinations available from the back-gearing, makes a total of 16 different speeds easily obtainable for the main drive.



BELTED DRIVE UPON A 54-IN. CAR-WHEEL BORING MILL.—WILLIAM SELLERS & CO.

VARIABLE-SPEED GENERAL ELECTRIC MOTOR.

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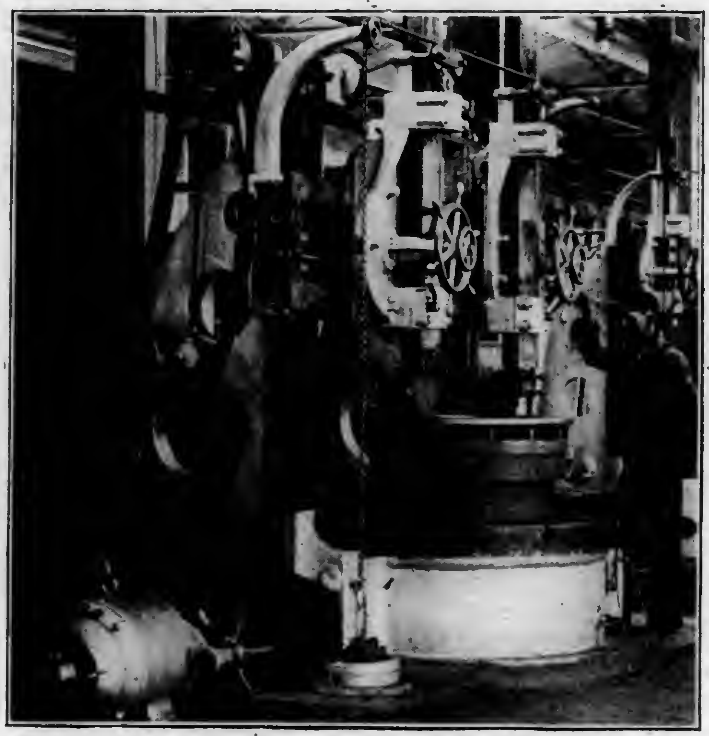
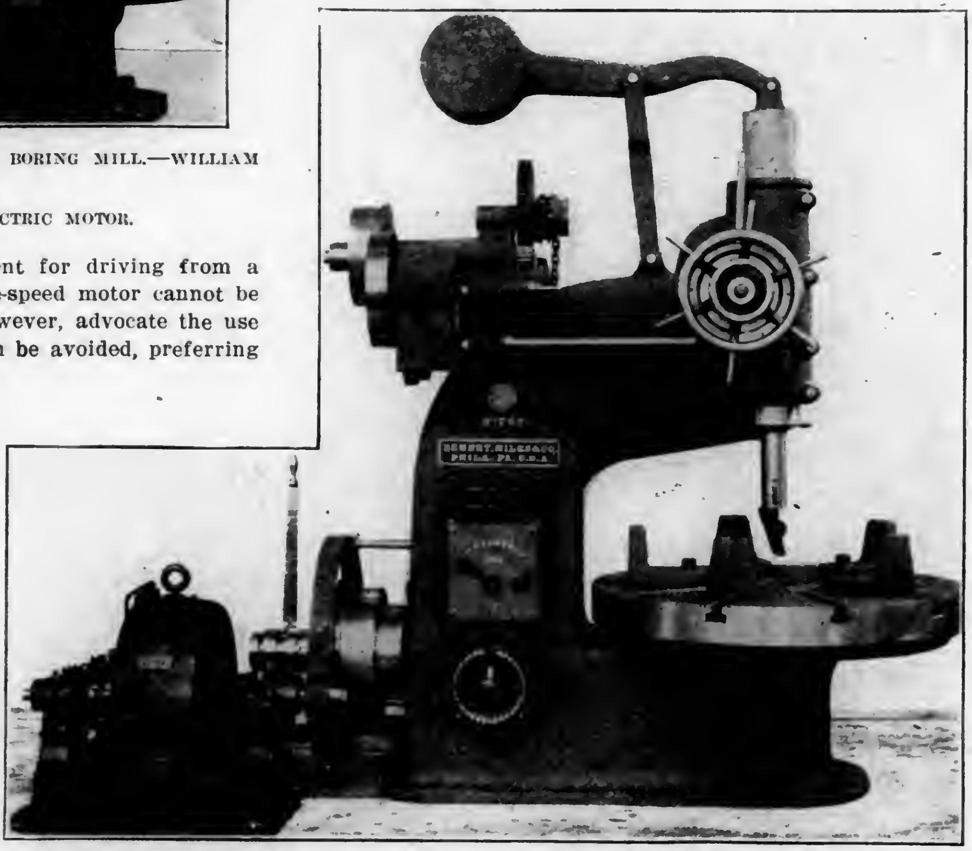
The engraving on page 245 is an illustration of a variable-speed motor drive applied to a 51-in. boring mill built by the Niles Tool Works Company. The motor used in this case is a 7½-h.p. multiple-voltage system motor, supplied by the Bullock Electric Manufacturing Company, Cincinnati, Ohio, and has a wide speed range in itself. It is mounted upon a separate sub-base bolted to the rear of the machine's frame, from which position it drives the main spindle direct through a gear reduction. The speed range available from the motor is doubled by a back-gear at the spindle drive, so that a very large range of speeds is possible for the drive. The compactness and convenience of the variable-speed method of driving are made especially apparent from this illustration.

The engraving immediately below illustrates a motor-driven boring mill at the works of the Bullock Electric Manufacturing Company, at Cincinnati. The tool is a large Niles boring mill



GEARED MOTOR DRIVE UPON A LARGE NILES BORING MILL AT THE WORKS OF THE BULLOCK ELECTRIC AND MANUFACTURING CO.



GEARED DRIVE UPON A 45-IN. CAR-WHEEL BORING MILL.—BEMENT, MILES & CO. VARIABLE-SPEED MOTOR BY FIELD CONTROL.—WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

and is driven by a 10-h.p. variable-speed motor operated upon the Bullock multiple-voltage system. It drives through a gear reduction and the usual back-gearing direct to the spindle

drive, thus furnishing a wide range of speeds. The controller for operating the motor is conveniently located on the base of the machine, near the operator's feet.

On the opposite page is shown an interesting motor drive upon a 54-in. car-wheel boring mill built by William Sellers & Co., Philadelphia, Pa. The motor is a 7½-h.p. variable-speed motor made by the General Electric Company. The method of mounting the motor is of especial interest in this case. It is carried by a bracket built up entirely of angles and channels, as is clearly shown in the engraving. The motor rests upon a bed of boiler plate, which is stiffened by channels beneath. This bed is mounted between angles bolted upon the upper side of the brackets, and is provided with an adjusting nut for raising it to tighten the belt by which the motor drives the machine. This makes a very strong and stiff, yet light and easily applied, construction for a motor support.

The remaining engraving opposite is an illustration of a motor drive as applied to a 45-in. Bement, Miles & Co. car-wheel boring mill. The motor driving this tool is a 10-h.p. Westinghouse variable-speed motor, which is connected directly to the driving shaft by a single large gearing reduction. A sufficiently wide range of speeds is available from the motor by field-resistance control to obviate the necessity of a back-gear attachment. The rheostat for the field control, as well as the main switch and starting box for the motor, are conveniently mounted at the side of the machine. The spindle feed and the wheel hoist are both operated by belt connection from the driving shaft.

LOCOMOTIVE TIRES, ALLOWANCE FOR WEAR.

In order to ascertain the practice of some of the leading railroads with reference to allowances for tire wear in preparing a standard for its own locomotives, the motive power department of the New York Central recently sent out a request for information, which resulted in securing the figures as arranged in the accompanying table. In a matter of this kind, in which so much expense is involved, uniform practice would be expected; but this table shows a variety of allowances. The minimum allowance affects other expenses than the cost of new tires, because usually the condition of tires determines the interval between shopping for general repairs. When from 7,000 to 10,000 miles may be made per 1-16 in. of wear the limit clearly becomes important as a commercial question. The last road in this list, under the notation "H," is the New York Central, and these dimensions have been adopted as standard practice on that road.

The New York, New Haven & Hartford Railroad has under contemplation a considerable extension of its high-speed electric equipment. Preparations are being made for the enlargement of its power house at Berlin, Conn., from which it is expected to operate its city street railroads in Meriden, 7 miles distant. It is probable that the successful third-rail service running out of Hartford to the West will be duplicated toward the East upon existing steam-operated branches, and also a rumor has gained current that the Harlem River branch running into New York City may be equipped for high-speed electric service for competition with the Portchester road now being built.

Our adherence to the tall chimney of our ancestors is worthy of a strict Confucian. A fan driven by a steam engine at 6 per cent. efficiency is still far more efficient than a chimney as a draft producer, provided other uses may be found for the heat contained in the gases. This excess heat may be greatly reduced by a radical change in the design of our boilers, while a further use for it may be found in heating air or water for warming buildings, or heating air for combustion.—E. S. Farwell, in *Engineering Magazine*.

"Cross-ties now cost more than twice the expense for rails." —P. H. Dudley, in *The Railway Age*.

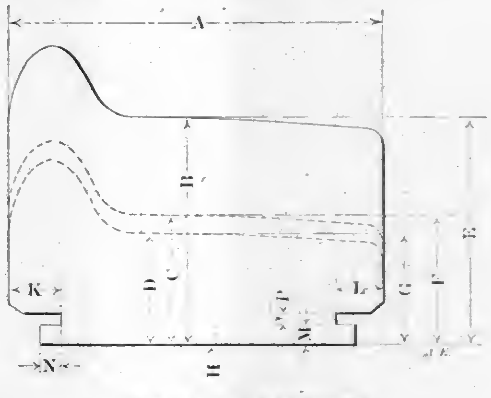


DIAGRAM OF DIMENSIONS.

ALLOWANCE FOR WEAR OF TIRES.

ROAD.	DESCRIPTION OF WHEEL.	Width. Inches.	WITHOUT RINGS. Inches. Thickness. New.	Minimum at Last Turning.	Minimum for Wear.	WITH RINGS. Inches. Thickness. New.	Minimum at Last Turning.	Minimum for Wear.	Min. Wheel Center with Rings. Inches.	Retaining Ring. Grooves. Inches.				
		A	B	C	D	E	F	G	H	K	L	M	N	P
A	74 inches Cent.	......	3	1 3-4	1 1-2	No Rings Used.				......	......	......	......	......
A	68 " "	......	3 1-2	"	"	......	......	......	......	......	......	......	......	......
A	62 " " Pass.	......	"	1 [illegible]-8	1 3-8	......	......	......	......	......	......	......	......	......
A	56 " " "	......	"	"	"	......	......	......	......	......	......	......	......	......
A	56 " " Freight	......	"	1 1-2	1 1-4	......	......	......	......	......	......	......	......	......
A	5[illegible] " " "	......	"	"	"	......	......	......	......	......	......	......	......	......
A	44 " " Switch	......	"	"	"	......	......	......	......	......	......	......	......	......
A	Other Switch	......	"	1 3-8	1 1-8	......	......	......	......	......	......	......	......	......
B	Switch	......	4	1 1-2	1 1-4 1 3-8*	No Rings Used				......	......	......	......	......
B	Road.	......	3 1-2	"	" "	......	......	......	......	......	......	......	......	......
C	......	......	3	1 1-2* 1 5-8	1 1-4* 1 3-8	3	*1 1-2 1 5-8	*1 1-4 1 3-8	56	M. 3-4 F.&B.7-8	M. 3-4 F.&B.7-8	5-16	3-16	5-16
C	......	......	3 1-2	" "	" "	3 1-2	" "	" "	"	M. 3-4 F.&B.7-8	M. 3-4 F.&B.7-8	"	"	"
D	44 inch Cent. Con.	5 3-4	......	......	......	2	1 3-4	1 1-2	44	15-16	13-16	5-16	3-16	5-16
D	45 T. Pass.	......	......	......	......	4	1 7-8	1 5-8	......	......	......	......	......	......
D	60 T. Pass.	......	......	......	......	"	2	1 3-4	......	......	......	......	......	......
E	......	......	3	1 11-16	1 7-16	......	......	......	72	......	......	......	......	......
F	Freight	5 3-4	3	1 1-4	......	No Rings Used,				......	......	......	......	......
F	Passenger.	5 3-4	3	1 1-2	1 7-16	......	......	......	......	......	......	......	......	......
G	Freight.	......	......	1 1-4	......	No Rings Used.				......	......	......	......	......
G	Passenger	......	......	1 1-2	......	......	......	......	......	......	......	......	......	......
H	Pass. 62 inches and over	5 1-2	3 1-2	2 1-8	1 7-8	3 1-2	2 1-8	1 7-8	......	3-4	3-4	5-16	3-16	5-16
H	" under 62 inches.	"	"	1 7 8	1 5-8	"	1 7-8	1 5-8	......	"	"	"	"	"
H	Freight.	"	"	1 5 8	1 3-8	"	1 5-8	1 3-8	......	"	"	"	"	"
H	Switch	"	"	1 1-2	1 1-4	"	......	......	......	......	......	......	......	......

* According to weight of engine.

Some idea of the strength and stiffness embodied in modern lathes may be gained from the fact that a recent lathe, using four tools, has reduced a steel shaft from 36 to 28 ins. in diameter at one cutting with a feed of ¼ in. That is to say, the depth of the cut was 4 ins., this depth being divided among the four tools.

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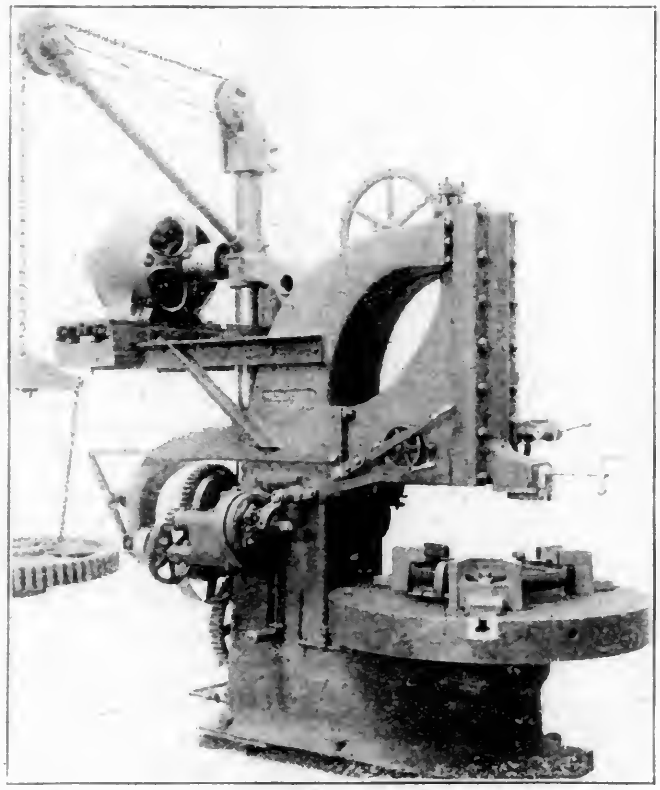

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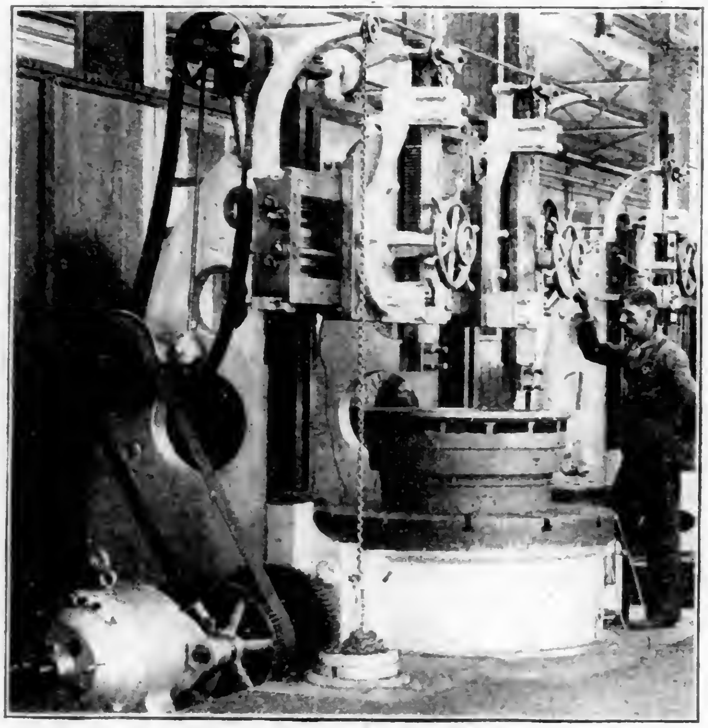
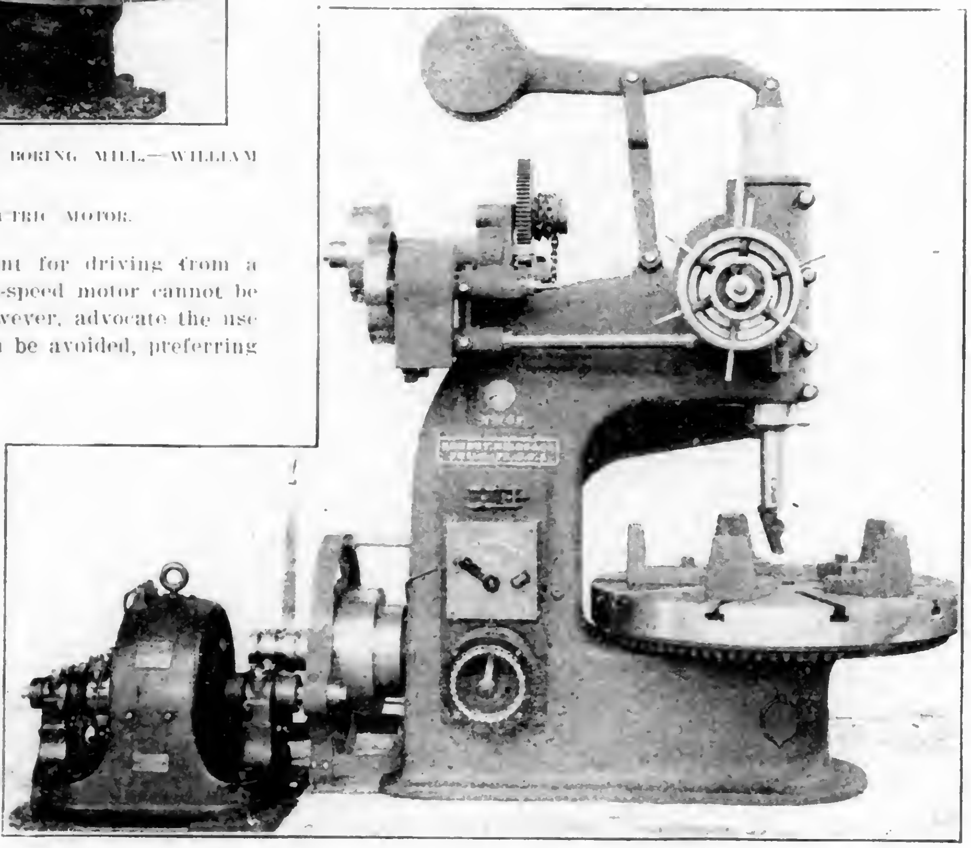


GEARED MOTOR DRIVE UPON A LARGE NILES BORING MILL AT THE WORKS OF THE BULLOCK ELECTRIC AND MANUFACTURING CO.



GEARED DRIVE UPON A 15-IN. CAR-WHEEL BORING MILL.—BEMENT, MILES & CO.
VARIABLE-SPEED MOTOR BY FIELD CONTROL.—WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

drive, thus furnishing a wide range of speeds. The controller for operating the motor is conveniently located on the base of the machine, near the operator's feet.

On the opposite page is shown an interesting motor drive upon a 54-in. car-wheel boring mill built by William Sellers & Co., Philadelphia, Pa. The motor is a 7½-h.p. variable-speed motor made by the General Electric Company. The method of mounting the motor is of especial interest in this case. It is carried by a bracket built up entirely of angles and channels, as is clearly shown in the engraving. The motor rests upon a bed of boiler plate, which is stiffened by channels beneath. This bed is mounted between angles bolted upon the upper side of the brackets, and is provided with an adjusting nut for raising it to tighten the belt by which the motor drives the machine. This makes a very strong and stiff, yet light and easily applied, construction for a motor support.

The remaining engraving opposite is an illustration of a motor drive as applied to a 45-in. Bement, Miles & Co. car-wheel boring mill. The motor driving this tool is a 10-h.p. Westinghouse variable-speed motor, which is connected directly to the driving shaft by a single large gearing reduction. A sufficiently wide range of speeds is available from the motor by field-resistance control to obviate the necessity of a back-gear attachment. The rheostat for the field control, as well as the main switch and starting box for the motor, are conveniently mounted at the side of the machine. The spindle feed and the wheel hoist are both operated by belt connection from the driving shaft.

LOCOMOTIVE TIRES, ALLOWANCE FOR WEAR.

In order to ascertain the practice of some of the leading railroads with reference to allowances for tire wear in preparing a standard for its own locomotives, the motive power department of the New York Central recently sent out a request for information, which resulted in securing the figures as arranged in the accompanying table. In a matter of this kind, in which so much expense is involved, uniform practice would be expected; but this table shows a variety of allowances. The minimum allowance affects other expenses than the cost of new tires, because usually the condition of tires determines the interval between shopping for general repairs. When from 7,000 to 10,000 miles may be made per 1-16 in. of wear the limit clearly becomes important as a commercial question. The last road in this list, under the notation "H," is the New York Central, and these dimensions have been adopted as standard practice on that road.

The New York, New Haven & Hartford Railroad has under contemplation a considerable extension of its high-speed electric equipment. Preparations are being made for the enlargement of its power house at Berlin, Conn., from which it is expected to operate its city street railroads in Meriden, 7 miles distant. It is probable that the successful third-rail service running out of Hartford to the West will be duplicated toward the East upon existing steam-operated branches, and also a rumor has gained current that the Harlem River branch running into New York City may be equipped for high-speed electric service for competition with the Portchester road now being built.

Our adherence to the tall chimney of our ancestors is worthy of a strict Confucian. A fan driven by a steam engine at 6 per cent. efficiency is still far more efficient than a chimney as a draft producer, provided other uses may be found for the heat contained in the gases. This excess heat may be greatly reduced by a radical change in the design of our boilers, while a further use for it may be found in heating air or water for warming buildings, or heating air for combustion.—E. S. Farwell, in *Engineering Magazine*.

"Cross-ties now cost more than twice the expense for rails."—P. H. Dudley, in *The Railway Age*.

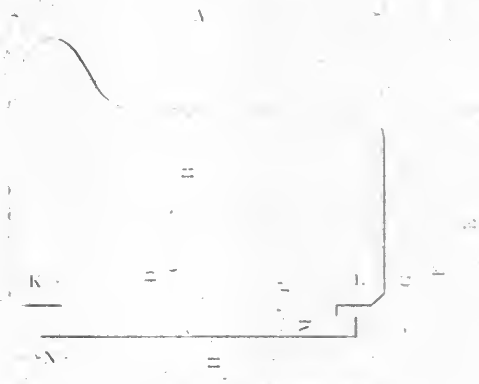


DIAGRAM OF DIMENSIONS.

ALLOWANCE FOR WEAR OF TIRES.

Road.	Description of Wheel.	Width Inches A	Without Rings, Inches, Thickness: New. B	Minimum at Last Turning. C	Minimum for Wear. D	With Rings, Inches, Thickness: New. E	Minimum at Last Turning. F	Minimum for Wear. G	Min. Wheel Center with Rings, Inches. H	Retaining Ring Grooves, Inches. K	L	M	N	P
A	71 inches Cent.		3	1 3-4	1 1-2	No Rings Used.								
	68 " "		3 1-2	"	"									
	62 " " Pass.		"	1 7-8	1 3-8									
	56 " " "		"	"	"									
	56 " " Freight		"	1 1-2	1 1-4									
	5? " " "		"	"	"									
	41 " " Switch		"	"	"									
	Other Switch		"	1 3-8	1 1-8									
B	Switch		4	1 1-2	1 1-4 1 3-8*	No Rings Used								
	Road		3 1-2	"	" "									
C			3	1 1-2*	1 1-4*	3	*1 1-2	*1 1-4	56	M. 3-4 F.&B.7-8	M. 3-4 F.&B.7-8	5-16	3-16	5-16
				1 5-8	1 3-8		1 5-8	1 3-8						
			3 1-2	"	"	3 1-2	"	"	"	M. 3-4 F.&B.7-8	M. 3-4 F.&B.7-8	"	"	"
				"	"		"	"						
D	41 inch Cent. Con.	5 3-4				2	1 3-4	1 1-2	41	15-16	13-16	5-16	3-16	5-16
	45 T. Pass.					4	1 7-8	1 5-8						
	60 T. Pass.					"	2	1 3-4						
E			3	1 11-16	1 7-16				72					
F	Freight	5 3-4	3	1 1-4		No Rings Used.								
	Passenger	5 3-4	3	1 1-2	1 7-16									
G	Freight			1 1-4		No Rings Used.								
	Passenger			1 1-2										
H	Pass. 62 inches and over	5 1-2	3 1-2	2 1-8	1 7-8	3 1-2	2 1-8	1 7-8		3-4	3-4	5-16	3-16	5-16
	" under 62 inches	"	"	1 7-8	1 5-8	"	1 7-8	1 5-8		"	"	"	"	"
	Freight	"	"	1 5-8	1 3-8	"	1 5-8	1 3-8		"	"	"	"	"
	Switch	"	"	1 1-2	1 1-4	"								

* According to weight of engine.

Some idea of the strength and stiffness embodied in modern lathes may be gained from the fact that a recent lathe, using four tools, has reduced a steel shaft from 36 to 28 ins. in diameter at one cutting with a feed of 1/4 in. That is to say, the depth of the cut was 4 ins., this depth being divided among the four tools.

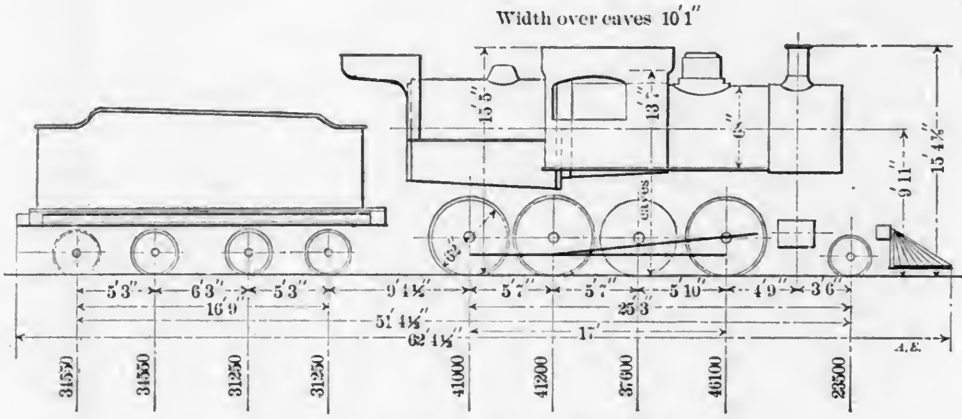
HEIGHTS OF LOCOMOTIVE BOILERS AND LOCOMOTIVE PROGRESS.

Discussions of the effect upon track of large locomotives and cars have led a correspondent to inquire the maximum height of the center of the boiler of an American locomotive, measured above the rails. The highest found in our record is that of a 2—8—0 (consolidation) type locomotive recently built for the Erie Railroad by the Baldwin Locomotive Works. This is known as "Class H 12" in the Erie classification and the height of the center of the boiler (68 ins. in diameter) is 9 ft. 11 ins. The height to the top of the stack is 15 ft. 4⅛ ins. The accompanying diagram is worthy of preservation.

The second in height of the center of its boiler is the 4—6—0 (ten-wheel) type, built in 1901 for the Chicago, Rock Island & Pacific by the Brooks Locomotive Works. This engine measures 15 ft. 7⅞ ins. to the top of the stack. The center of the boiler is 9 ft. 10⅞ ins. above the rail. If readers know of locomotives with boilers higher than these they will confer a favor by communicating the fact. This Erie locomotive boiler is probably 10 ft. high with new tires and new springs.

Progress in locomotive proportions has been more rapid than anyone can possibly realize without a glance at the practice of a few years ago. It is interesting to note the suggestion contained on page 52 of this journal for February, 1888, to the effect that the center of a locomotive boiler might perhaps sometime reach the height of 9 ft. In that article the statement was made that between 1858 and 1888 the size and weight of passenger locomotives had doubled, and the question was asked: "Will this rate of increase continue, and in the year 1918 will there be passenger engines running which weigh 200,000 lbs. and over?" The reader will note that the new Chicago & Alton passenger locomotives weigh 219,000 lbs. which is 10 per cent. more than the prediction for attainment fifteen years hence. In June, 1900—less than three years ago—Mr. William Forsyth suggested the possibility that in 1905 the total heating surface of freight locomotive boilers might reach 4,000 sq. ft. In our June number of last year the Santa Fe 2—10—0 (decapod) was illustrated. It has 5,390 sq. ft. of heating surface.

Predictions for the future may be amusing, but their value is small. This rapid progress in size and weight emphasizes the relatively small progress in efficiency in the methods of utilizing the weight. It is time to turn attention to obtaining the utmost capacity from present weights, and this is the most difficult problem.



A LOCOMOTIVE WITH A HIGH BOILER.—ERIE RAILROAD.

Cylinders ....21 x 28 ins.	Flues, number 298
Weight on drivers ....165,900 lbs.	Flues, length ....13 ft. 2 3-16 ins.
Total weight in working order.....189,400 lbs.	Heating surface, flues ....2,224 sq. ft.
Diameter of drivers ....62 ins.	Heating surface, firebox ....167 sq. ft.
Ratio heating surface to grate area.........32	Heating surface, total ....2,391 sq. ft.
Ratio heating surface to cylinder volume...198	Grate area ....75 sq. ft.
Tractive power per lb. M.E.P..........199.16	Firebox, length ....113 ins.
	Firebox, width ....96 ins.

Tender.

Capacity, coal ....12 tons	Weight, empty ....52,400 lbs.
Capacity, water ....6,000 gals.	Weight, loaded ....126,400 lbs.

COMPARATIVE TESTS OF CALIFORNIA CRUDE OILS.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

A series of tests was made recently by the Santa Fe Railway on the crude oils found in California, to determine the relative evaporative values of the light, high gravity oils found in the southern part of the State and the heavy, low gravity oils found farther north. These tests were made both on the stationary plant at the San Bernardino shops, and to obtain service conditions on consolidation engine No. 719, having 21 x 28-in. cylinders, 31,100 lbs. tractive force and carrying 180 lbs. steam pressure. In both cases the water evaporated and the oil consumed were accurately measured in calibrated tanks, temperature and pressures taken, and in the case of the stationary tests, injector overflow measured and deducted, it being the intention to secure as accurate data as possible.

SUMMARY OF FUEL OIL TESTS MADE ON SAN BERNARDINO STATIONARY PLANT AND ENGINE NO. 719 WITH OILS "A," "B" AND "C."

Tests made on..........	Stationary Plant			Engine 719		
Kind of oil used........	"A"	"B"	"C"	"A"	"B"	"C"
No. of tests made......	5	7	7	5	4	4
Pounds water evaporated per pound oil..........	11.23	11.72	11.12	10.65	11.10	10.67
Pounds water evaporated per pound oil in per cent. using "A" oil on stationary and road as basis (100 per cent.)..	100	104.26	99.02	100	104.23	100.79
Gravity of oil (Beaume at 60° F.)	19.03	19.56	12.1	17.7	19.1	13.5

The tests first made were to determine the difference between ordinary and southern California oil, as it is delivered in the oil cars from the fields, being a mixture of a large number of wells, and which we will call oil "A," and oil from a particular well in the same district whose analysis showed a higher thermal value than is found in the ordinary oil, which we will call "B." Reports of tests between these two oils on both road engine and stationary plant are shown in the table, and it will be noted that the difference in evaporative value of the two oils is small, being 4.36 per cent. in the stationary tests and 4.23 per cent. in the road tests, in favor of the special oil "B." The fact that two sets of tests made in such widely different service check so closely in the results would seem to indicate the accuracy of the tests. The oil "B" did not show the increased evaporation over oil "A" that a comparison of their B. T. U. would lead one to expect. This was explained by the fact that the well from which oil "B" was obtained was a heavy producer and ordinarily the oil from all of the wells is mixed together in the storage tanks, so that there

was not so great a difference between the two oils as had previously shown in their analyses.

Other tests made with heavy, low gravity oil "C" show an evaporation surprisingly close to that of the lighter oils "A" and "B" in spite of the marked difference in the per cent. of kerosene, gasoline, asphaltum, etc., present in the two oils.

Below is a summary of an analysis of the two oils:

	"A"	"B"	"C"
Calorific value B. T. U.	16,492	18,960	17,112
Per cent. sulphur	2.22	3.4	2.
Per cent. gasoline	5 to 20	4.6	none
Per cent. kerosene	36.88	23.	20.25
Per cent. residue (about)	25.60	72.	70.75

It will be noted by referring to the tests that the temperature of the oil as it went to the burner was very much higher with oil "C" than with the lighter oils "A" and "B," because the pressure of such a large asphaltum base made the oil very sluggish and required considerable heat before it would feed down to the burner freely. On the first road test made with this oil (C) the engine left the terminal with the temperature of the oil about 80 deg. F., and for about half an hour, or until the heater coil could get the oil hot, the fireman kept the oil feed valve wide open, and in spite of this the steam pressure ran back about 50 lbs.

All of these are California crude oils. Oil "C" is very thick, almost like asphalt when liquified by heat. The oils "A" and "B" are in appearance ordinary liquid crude oils and are obtained in southern California, while "C" is obtained at about the center of the State. It is interesting to note that although the appearance and analyses of the oils differs widely, yet one may be made to do as good work as another. It is also interesting to see how closely the tests on a stationary boiler and on locomotives agree with each other.

This information was furnished by Mr. G. R. Henderson, superintendent of motive power. The tests were carried out by Mr. G. R. Joughins, mechanical superintendent of the coast lines, the data having been taken by Mr. R. S. Wickersham, assistant engineer of tests.

A student grade of membership has been established by the American Institute of Electrical Engineers, conferring upon students regularly pursuing electrical studies the following: 1. The privilege of being present at all meetings of the Institute, except such business meetings as relate to the management of the Institute. 2. The privilege of receiving the regular announcements and printed copies of monthly transactions. 3. The privilege of purchasing the semi-annual bound volumes of the transactions of the Institute at the price of $3.50 per copy, or such other price as may be hereafter fixed by the board of directors. Certain easy requirements must be met and these privileges cannot be had by anyone for more than three years. Students are not limited to technical schools, but include those pursuing electrical studies in the correspondence schools or privately. In connection with this idea a number of local or branch meetings of the Institute have been established at fourteen of the leading technical schools.

The Fresno City Railway Company, of Fresno, Cal., has recently placed in service a 20-ton electric locomotive car for the purpose of hauling freight cars, and also carrying freight and supplies. This line is an outlet for a heavy shipping district and transfers a great deal of freight to the steam roads. The locomotive is driven by four motors of 50-h.p. each, one upon each axle, and is equipped with standard automatic couplers. The car was furnished by the J. G. Brill Company, Philadelphia, Pa., the trucks used being the improved Brill No. 27 high-speed type.

AN ARGUMENT FOR BLUE LEAD.

By a slip which cannot be blamed upon compositor, printer or office boy, under the heading "Blue Lead as a Pigment for Paint," on page 198 of our May number, an error occurred in the first line, which should read, "An argument in favor of blue lead as a pigment."

EQUIPMENT AND MANUFACTURING NOTES.

The Lunkenheimer Company. Cincinnati, report that on account of the unprecedented demand for their brass and iron steam specialties they have been compelled to increase their foundry output 50 per cent. Machine tools of the most improved types are being installed in various departments as fast as they can be obtained.

The Columbus Steel Rolling Shutter Company, Columbus, Ohio, inform us that they have appointed the F. P. Smith Wire and Iron Works, 100-102 Lake street, Chicago, manufacturers of ornamental and structural iron, art brass and wirework, sole agents in Chicago and several other States adjacent thereto for the sale of the Columbus rolling steel doors for freight houses, shop buildings, car-barns, warehouses, etc., owing to the large number of orders coming in from the West.

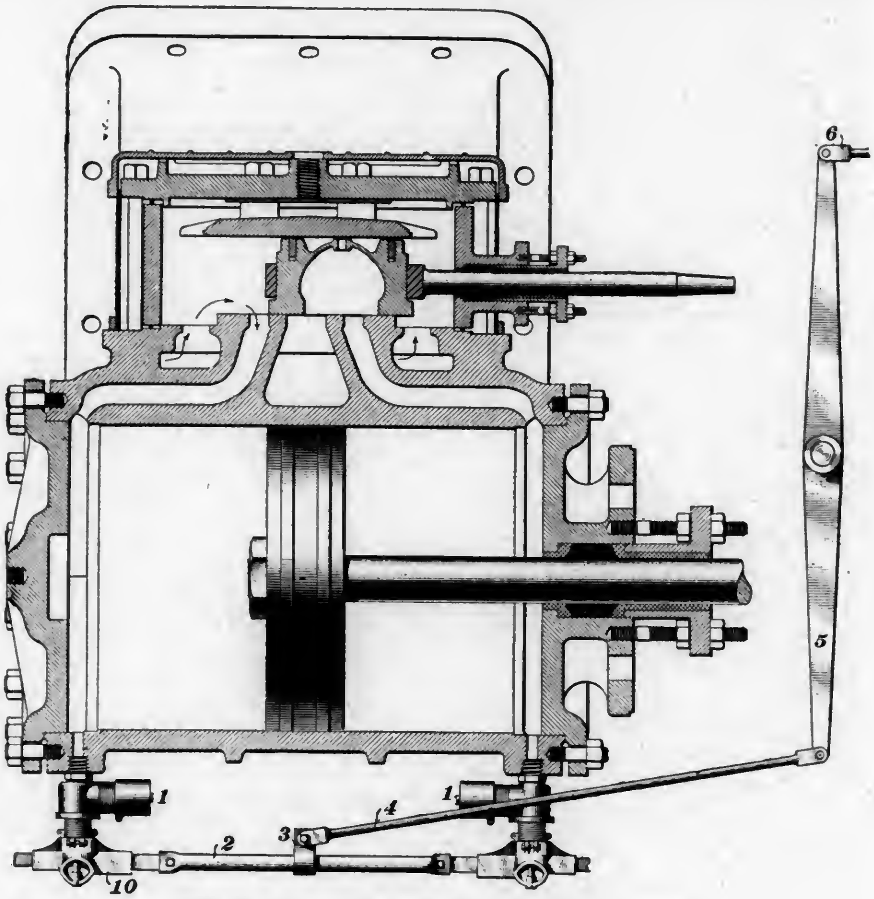
Mr. W. O. Duntley, of the Chicago Pneumatic Tool Company, has just returned from a short business trip abroad in the interests of his company. While on the Continent he visited several of the most prominent shipyards and manufacturing establishments and brought back with him a large number of orders for the various pneumatic appliances manufactured by his company. Mr. Duntley expresses himself as somewhat astonished at the readiness with which European industries adopt American labor-saving machinery, and in speaking of his trip says: "American labor-saving machinery is indeed becoming firmly established in the old countries. Particularly is this true of pneumatic appliances, and in the large majority of the shops, and especially in the prominent shipyards which I visited. 'Boyer' and 'Little Giant' pneumatic tools were in continuous service and giving excellent satisfaction. The large English and German ship owners have adopted pneumatic tools almost exclusively, and although occasionally an instance will be found where the old hand methods still prevail, they are certainly the exception rather than the rule, as was the case but a few years ago. Our foreign plants are taxed to their utmost capacity to adequately fulfill requirements, and in all probability extensive improvements will be necessitated in order to take proper care of the immense influx of business. In fact, the outlook for pneumatic tool business on the Continent is most promising indeed and all indications point toward a record-breaking year in the pneumatic tool industry, both for foreign and domestic business."

Mr. A. Rieppel, Koeniglicher Baurat, of Nurnberg, Germany, the managing director of the Augsburg Nurnberg Manufacturing Company, well known for many years as one of the largest and most successful builders of structural iron work, engines, cars, bridges, etc., in Europe, is now visiting this country. His works employ about 16,000 men and now have over 2,000 at work on the bridges of the new railroads being built by Germany in China. Their latest success has been with gas engines, both for gaseous and liquid fuel. They have long built these engines in smaller units up to 400 h.p. and operated with petroleum, but for the use of waste gas as well as producer gases and in larger units, they have recently developed an entirely new design constituting the result of many years of extensive experience. The engine, which is of the double-acting type, generally in tandem arrangement, is adapted for the various purposes of modern power development up to the largest units required by municipal central stations and iron and steel works. Mr. Rieppel's visit to this country was made to interest the Allis-Chalmers Company in the manufacture of the products of his company. A contract was entered into by the two companies giving the Allis-Chalmers Company the exclusive right to manufacture and sell the Nurnberg gas engine for this country and selling rights in many foreign countries, especially the Far East and South Africa. The Augsburg Nurnberg Manufacturing Company, under the direction of Mr. Rieppel, has made a phenomenal success with this new gas engine, having within the past few months received orders for some 50,000 h.p. throughout Germany and Spain, chiefly for generating electric energy and for blast furnace and spinning mill work. One of these engines now being built is for an important spinning mill in northern Germany where the engine will be operated by producer gas. Mr. Rieppel is now on a tour of inspection throughout this country, after which he will visit the new and extensive works of the Allis-Chalmers Company at West Allis, where these engines will be built.

ZEHNDER AUTOMATIC RELIEF VALVE.

The accompanying illustrations show the Zehnder patent locomotive automatic vacuum compression and excess pressure relief valve, with cylinder cock attachments and auxiliary oiling device. By the use of this valve the vacuum and compression in the cylinders can be adjusted to and maintained at any desired amount, thereby increasing the power of the engine, reducing the coal consumption and causing the engine to ride more easily.

Fig. 1 is a sectional view of the valve, and Fig. 2 shows a sectional view of the cylinder of a simple locomotive with the cylinder automatic relief valves attached, showing connections by which the valves are governed from the cab. Referring to Fig. 1 valve 6 acts as a compression and vacuum relief and cylinder drain cock. It works automatically, except when held open or shut by the engineer through the medium of the cylinder cock levers as shown in Fig. 2. The normal position of this valve is open, being held by the spring 7, the tension of which is adjusted by the cap nut 9, to give the desired compression in the cylinder. When steam is admitted into the cylinder it closes valve 6 and holds it closed until the exhaust opens and reduces the pressure below the tension of spring 7, the valve then opens and remains so until the compression becomes sufficient to close it. The amount of compression therefore depends upon how late in the stroke valve 6 closes, being reduced by a late closure and increased by an early closure. The tension of spring 7 should be adjusted to give just sufficient compression to properly cushion the piston. In drifting, valve 6 opens and relieves the vacuum that otherwise would be formed. Valve 3 prevents excessive pressure in the cylinder, the spring 4 being adjusted to resist a pressure slightly above boiler pressure. The auxiliary attachment, 12, is provided for lubricating cylinders in the event of the failure of the regular lubricating devices or a break-down necessitating the blocking of the steam valve, but permitting the main rod being left up. These valves are now being put on the market by C. F. Beckwith & Co., of Scranton, Penn., as general agents for the Zehnder valves. Detailed information will be furnished on application.



ZEHNDER AUTOMATIC RELIEF VALVE.

FIG. 2—SECTIONAL VIEW OF CYLINDER.

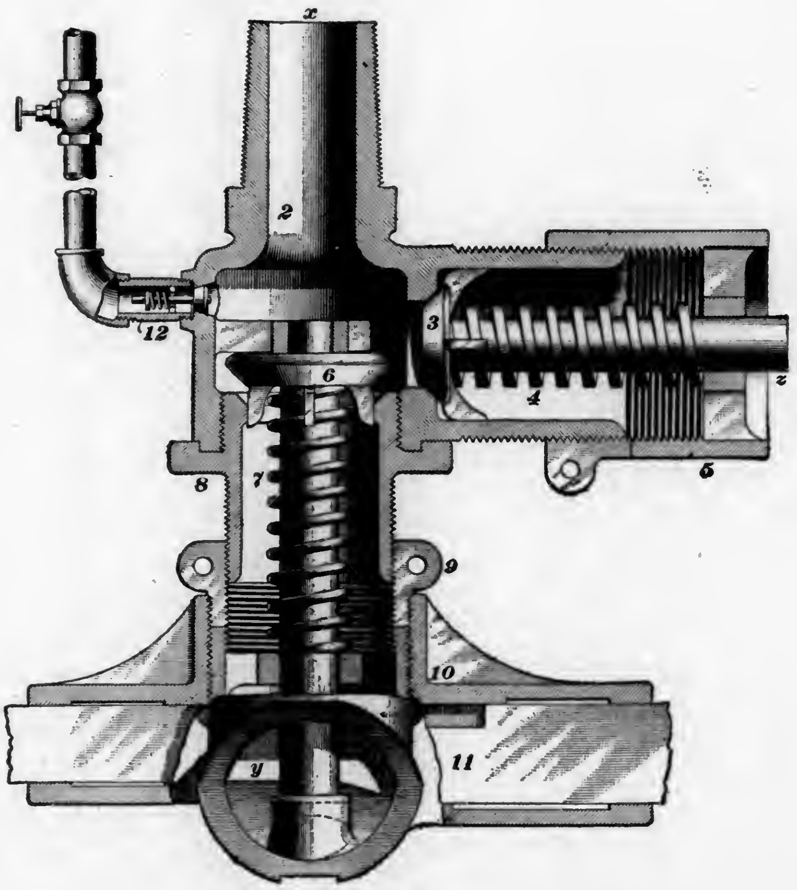


FIG. 1.

A high-speed run was recently made upon the Aurora, Elgin & Chicago third-rail electric railway which is said to be a record-breaker for electric railroad practice. A single-motor car made a special run, under regular traffic conditions, from the Chicago terminal at Fifty-second avenue to Aurora—a distance of 35 miles—in 34½ minutes. During a spurt 5 miles of the run were made in 4 minutes and 5 seconds, a rate of speed corresponding to 73½ miles per hour. This is claimed to break the record for constant running for long distances upon electric railways.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

JULY, 1903.

CONTENTS.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

SARATOGA, N. Y., JUNE 24-26, 1903.

The convention was opened by the president, Mr. G. W. West, with the usual formalities, the attendance being unusually large. The presidential address began with a brief review of the extraordinary conditions of congestion on the railroads because of large volumes of business during the past year. This had brought new problems, which had been successfully solved. Tonnage rating was regarded as a most important element in train operation. By placing the rating of locomotives in the hands of one man, a gain of one train in five had been obtained with one class of locomotives. Tonnage rating, however, had been overdone. With the introduction of the wide firebox on locomotives had come a danger of a considerable loss through waste of fuel while standing still. The speaker believed that locomotive failures should come before the association in discussions. He had found that 20 per cent. of the failures represented 80 per cent. of the cost. High-speed tool steel was referred to as a great blessing in permitting the increase of capacity of old tools. This amounted to as much as 100 per cent. in some cases. During the past year 3,582 locomotives had been built in this country, which was equivalent to one every working hour during the year. Of these locomotives, 1,297 weighed 90 tons or over, and 742 were compounds. The speaker then supplemented the remarks of President Waitt last year on the opportunity presented the association in the matter of scientific research, which was greatly needed. He referred to the recent legacy of $1,000 from Jerome Wheelock for this purpose, and urged the necessity for establishing representative membership in order to defray the expenses involved in systematic work of this kind. He also referred to THE AMERICAN ENGINEER Tests, which received the endorsement of the association last year. He said:

"Attention was directed last year by President Waitt to the elaborate series of tests on locomotive draft appliances which are being conducted at Purdue University by Professor Goss for THE AMERICAN ENGINEER AND RAILROAD JOURNAL at its own expense. The association endorsed this commendable undertaking by authorizing the Executive Committee to assist in the work, which will be reported upon at this convention by a special committee. This research has already placed the study of stacks beside that of exhaust nozzles, which were investigated by the association in 1896. Much yet remains to be done in order to apply the best methods of design to large locomotives. The conclusions of Professor Goss with reference to stacks appear in the current number of THE AMERICAN ENGINEER, revealing valuable results already attained and indicating important lines for further investigation."

The address was a thoughtful and able review of the motive-power situation.

In the report of the secretary it was shown that the active membership was 699, associate 17, honorary 36, or a total of 752. The funds in the hands of the treasurer amounted to $3,085.66, with no outstanding bills. This amount included a legacy of $1,000 from Jerome Wheelock, which, it is understood, is to be used for research work by the association. The Executive Committee suggested the following changes in the constitution for the purpose of providing additional funds for this work:

Article 3, Section 1, an addition: "One representative member may be appointed by any railroad company to represent its interests in the association; such appointment shall be in writing, and shall emanate from the president, general manager or general superintendent. Such member shall have all the privileges of an active member, including one vote on all questions, and in addition thereto shall, on all measures pertaining to the determination of what tests shall be conducted by the association or the expenditure of money for conducting same, have one additional vote for each full 100 engines which are in actual operation or in process of purchase by the road or system which he represents. Such membership shall continue until notice is given the association of his withdrawal or the appointment of his successor."

Article 3, Section 3, an addition: "Representative members shall pay, in addition to their personal dues as above, an amount for each additional vote to which they may be entitled, as shall be determined each year by the Executive Committee, pro-rated upon the cost of conducting such tests as may be determined upon at each convention; provided, that no assessment shall exceed $5 per vote per year."

Under the rules this must wait until next year for final action. There was no discussion.

A committee was appointed to take up with the Interstate Commerce Commission the question of applying hand-holds and grab-irons to locomotive tenders, which are required by the safety-appliance law.

An invitation was received from President Francis, of the St. Louis Exposition, to hold the next annual convention of the association at St. Louis in connection with the exposition.

TOPICAL DISCUSSIONS.

Long Locomotive Flues.—This subject was presented by Mr. H. F. Ball, who stated in general terms that long flues give no more trouble than short ones. Mr. Humphrey stated that he was not at all afraid of 20-ft. flues after his experience with them on the Chicago & Alton. Mr. Humphrey mentioned the matter of design of six-coupled locomotives with large drivers, which necessitated long tubes. In the recent Chicago & Alton 4—6—2 locomotives with 20-ft. tubes no trouble had been found. The additional heating surface incidentally obtained was somewhat beneficial. These engines had shown remarkable steaming qualities. Professor Goss said: "It goes without saying that if the length of the tube can be increased, there will be advantage in the performance of the boiler, provided the number is not reduced, so that as the subject appeals to me it is one of difficulties to be met with in increasing the

length of the tube. These difficulties, I fancy, are those of maintenance, keeeping them tight, and perhaps the disadvantage of reduced draft. Now, if these disadvantages do not appear in the experience which has been with the long tube, it seems to me the argument is very strongly in favor of the more general use of longer tubes."

Methods of Setting Tubes.—Mr. Miller (P., C., C. & St. L.) believed it positively detrimental to use roller expanders which thinned the tubes. Roller expanders also distorted the holes in the flue sheets. Construction which would permit the tube sheets to yield as diaphragms was advocated and supported by a record of experience. Mr. Lawrence pointed to the fact that with increasing pressures flue practice had not advanced. Much of the present trouble was due to careless work at ash pits. Mr. Tonge had found it very beneficial to discard flue rollers. Cleaning flues and careful fitting to the sheets, the use of wide copper ferrules were all necessary. Mr. Humphrey believed the diaphragm construction to be the field for progress in overcoming flue troubles, which he characterized as serious and due to local conditions and a large number of causes. Mr. Bartlett reported favorable experience with spirally corrugated tubes on the Boston & Maine. The spiral corrugations apparently provided for expansion. Flue and other boiler troubles are evidently considered as the most important locomotive problems before motive power men to-day.

Grinding as a Method of Finishing Piston Rods and Valve Stems.—Mr. Vaughan introduced this subject by stating that his subject referred to grinding by the use of high pressures and the employment of stops. A very rigid machine was absolutely necessary. The work was done to save lathe cuts and secure accurate finish as compared with filing. As a result a piston rod could be centered and rough turned in about 1½ hours and could be completely finished by grinding in from 16 to 18 minutes. Valve stems requiring 45 minutes for lathe and file finishing could be ground in 10 to 12 minutes. Crank pins required 1 hour 45 minutes for centering, roughing, threading and finishing in the lathe, as compared with 20 to 22 minutes for grinding. Old rods with pistons on were ground just as they came from the engines in 30 to 35 minutes, whereas lathe work required 1 to 1¼ hours. Old valve stems were ground in 25 to 30 minutes. The speaker placed great emphasis on the necessity for rigid grinding machinery, and was strongly in favor of grinding as a process in locomotive work.

Mr. Norton, of the Norton Emery Wheel Company, was given the privilege of the floor and spoke of the development of the manufacture of grinding wheels, which had exerted a vital influence on the possibilities of grinding. To-day soft steel is removed by wheels at a rate of a cubic inch of metal per minute. Machine tool features, rather than refinements for grinding, were now applied in grinding machinery. Pressures up to 6,000 lbs. were used in grinding large pieces, such as shafts. The utmost rigidity was necessary in the machines.

New Tool Steels.—This subject was presented by Mr. S. K. Dickerson (Lake Shore & Michigan Southern), who related experience at the Collinwood shops. As an instance of what could be done, he stated that fourteen tires had been bored with one tool for roughing out. It had been found that it often required more time to put work into readiness than was required for the cutting, which made it desirable to provide improved facilities for setting work. In many cases machines had failed to hold up the cut which the steel would carry. In boring tires speeds of 36 to 40 ft. per minute were used, and in turning tires, outside, speeds of 18 to 20 ft. The discussion showed the great importance of the new high-speed steels in all materials except cast iron, or on work which is light. Mr. Vaughan believed that the introduction of these steels constituted the greatest improvement in machine work in recent times. There had been a general waking up to a study of speeds and feeds and methods of putting work into machines which was not the least important effect of the steels. It would pay to spend more money on jigs and methods of reducing the labor charge and the cost of manipulating the tool. The new steels had done a service in drawing attention to this fact. It would not do to stop with the steel itself. It requires perhaps twelve minutes to make a cut and an hour to set the work. The discussion was lively and interesting, reflecting the fact that tool steels are revolutionizing shop practice.

Range of Weights of Principal Parts of Locomotives.—Mr. R. H. Soule placed on record the weights of a number of heavy parts of locomotives which he had secured in connection with the determination of the capacities of traveling cranes for shops. A large amount of this information will be presented in the proceedings. In his remarks he gave a few very interesting figures, as follows:

"The heaviest weight of the complete boiler that is recorded is the Santa Fe tandem compound decapod by the American Locomotive Company, which weighs 66,313 lbs. That indicates, at once, in order to be safe and leave some little margin, that a general boiler shop crane which is going to handle all kinds of boilers should not be of less than 35 tons' capacity. The next item worthy of note is that of cabs; the heaviest wooden cab reported weighs 1,520 lbs., and the heaviest steel cabs will weigh over 1,000 lbs. more than wooden cabs. A full set of frames on the engine referred to weighs 21,200 lbs., which indicates that a 10-ton crane is not sufficient to handle them, and will probably require a 15-ton crane. A pair of cylinders bolted together complete in the case of the same heavy Santa Fe tandem compound decapod engine will weigh 27,420 lbs., showing at once nothing less than a 15-ton crane would be safe to provide for handling that class of work. The heaviest driving axle reported, referring to the same engine, weighs 1,875 lbs.; a pair of driving wheels on axles the same engine, being the main wheel with eccentric and straps on, weighs 9,855 lbs. Engine truck complete, Atlantic type, New York Central engine, weighs 10,250 lbs., something over 5 tons. The tender tank reported by the Baldwin Company weighs 13,680 lbs., showing at once that a 7½-ton crane is necessary; the tender truck complete, 9,060 lbs.; the tender complete, without coal or water, 48,900 lbs."

INDIVIDUAL PAPERS.

Draw Bars Between Locomotives and Tenders.—This paper, by Mr. Henry Bartlett (Boston & Maine), is presented in abstract. Mr. Wm. Forsyth differed with the author with reference to the use of springs and believed that the employment of friction draft gear on the rear ends of tenders would reduce the duty of the engine draft gear. Mr. Bartlett stated his opinion that there should be a positive tie, with no lost motion between engines and tenders. This was the more necessary with large locomotives. Mr. Vaughan believed a spring connection desirable, because it made it possible to utilize a portion of the weight of the tender to assist in steadying the engine. A flat buffer was preferred to a rounded form, because of providing wearing area and preventing cutting on curves. Mr. Van Alstyne favored spring connections, and argued in favor of greater capacity of the springs. He also believed wide, flat wearing plates desirable. The discussion was decidedly favorable to spring connections.

At this point a letter from Mr. F. D. Casanave, of the Pennsylvania Railroad, was read, stating that that road would install a locomotive testing plant as a part of their exhibit at the St. Louis Exposition, requesting the association to appoint a committee of four to represent the association in connection with tests of locomotives on the plant. Mr. F. H. Clark (C., B. & Q.) presented resolutions authorizing the president to appoint this committee. This important project evidently impressed the members. The resolutions were adopted.

Internal Combustion Engines.—This paper will appear in abstract. Mr. Soule did not think that the author had given fair consideration to the steam engine. He showed from the published accounts of the Collinwood shops that a horse power could be delivered at the motors on a consumption of 3 lbs. of coal and did not consider the gas engine as a strong competitor of steam.

The Metric System.—Mr. Angus Sinclair presented an individual paper urging the association to take official action condemning all legislation intended to promote the adoption of

the metric system in this country, and including resolutions which the author suggested in this connection. The paper was directed against the bill which will be again brought before Congress with the object of compelling the use of the metric system in government work, and cited as an objection the fact that nothing but confusion would result. Experience in so-called metric countries abroad had proven that the old units remained in use, and it was believed to be not only impossible to generally introduce the metric system in this country, but it was entirely unnecessary to attempt to do so in order to maintain trade with metric countries. The paper presented the case ably and concisely. After a very short discussion the resolutions were adopted, committing the association to a policy adverse to the metric system.

Light for Locomotive Headlights.—Mr. Wm. McIntosh read a brief statement concerning various methods of lighting locomotive headlights which will be referred to more fully in a future issue.

Effect of Tonnage Rating Upon the Cost of Conducting Transportation.—This paper will appear in abstract. Opinions expressed in the discussion were generally favorable to the views of the author as to the desirability of reducing maximum tonnage ratings to a basis which would permit of economical operation.

DISCUSSION OF COMMITTEE REPORTS.

Revision of Standards.—The adoption of M. C. B. standards for bolt heads and nuts was recommended; also that the distance between the backs of flanges of driving wheels be not less than 4 ft. 5⅛ ins. It was suggested that a committee be appointed to revise the shrinkage allowance for driving-wheel tires to provide for cast-steel wheel centers. The standard tire section was found to contain an error, and should be made to conform to that of the M. C. B. Association. At present steel tubes are not provided for in the standard tube specifications. It was recommended that these be included, that the M. C. B. standard axles and journal boxes be adopted by this association and that committees be appointed to revise the specifications of cast-iron wheels for tenders, and to revise the air brake and signal instructions. The recommendations were approved.

Piston Valves.—Mr. F. H. Clark presented the subject, calling attention to the apparent preference for the hollow piston valve because of its superior balancing features. Relief valves were believed to be somewhat deficient in meeting the expectations. Considerable difficulty had been experienced in the use of L-shaped rings. The shape of the section was important, and a short lip of the L seemed to be satisfactory. Good results had been secured from the new balanced slide valve (the American). A flexible connection in the valve stem was recommended in order to reduce the wear of valves. Straight bridges were believed to be more satisfactory than those cut diagonally.

Mr. Van Alstyne reported a difference of 6 to 1 in favor of piston valves in the matter of valve failures and 7 to 1 in Baldwin and cross compounds, running in the same service. A speaker gave, from the standpoint of traveling engineers, a very favorable opinion of piston valves. He referred to the weight of large valves as an important matter requiring attention. Mr. John Player presented interesting comments on piston valve practice, which will be referred to in another issue. It seemed to be the general opinion that while piston valves were not perfect, they constituted an improvement over the old form of slide valves. Mr. David Brown compared the piston valve to "a new baby in the family which needed looking after." The recommendations of the committee were referred to the executive committee.

Recent Improvements in Boiler Design.—This report will appear in abstract. Mr. Van Alstyne indicated the great importance of wider water spaces, not only at the mud rings, but also at the crown sheets. Flue troubles were not taken care of completely by anybody, and by most people not at all. They constituted a very serious problem. Mr. Player made an admirable argument for better circulation of water in boilers. This report led to a rather lengthy discussion of the details of boiler construction. Mr. O. H. Reynolds directed attention to D. K. Clark's recommendations for tube spacing, which if carried out to-day would lead to much larger spacing. He wished to have tests made to demonstrate the facts with respect to tube spacing. Mr. Humphrey made a strong plea for further investigation of boiler troubles with a view of ascertaining how to construct boilers to overcome present troubles. He believed that if the association considered this subject only, next year, the time would be well spent, so important was it. The committee was continued, with instructions to carry on investigations at the expense of the association.

Electrically Driven Shops.—Mr. C. A. Seley, chairman of the committee, presented this admirable report, which is printed nearly in full in this issue. The speaker favored a three-wire system for general shop requirements. For lamp circuits 110 volts offered decided advantages. He was satisfied to accept 100 per cent. field control and 4 to 1 speed variation with a three-wire system for new shops now under construction under his direction. It was a simple system, and simplicity in electrical matters was very desirable. Mr. R. H. Soule considered condensing apparatus for power plants undesirable. He also mentioned crane service as one absolute necessity in modern shops. Mr. Soule referred to the absence of large cranes in the new shops of the Great Northern at St. Paul as an interesting development. Mr. Pomeroy spoke in favor of field control of various speed motors, it being commercially and electrically desirable. The maintenance of the horse power through the range of speeds was necessary. Such motors were fully developed and were considered standard commercially. Such motors would stand much higher overload at the low than at high speeds. Variable speeds without loss of efficiency were important. Variations of three to one on two wires had been successfully used at the works of Messrs. Vickers & Maxim in England.

Mr. Vaughan discussed the report from the standpoint of the four-wire, multiple voltage system of the Crocker-Wheeler Co., at the Collinwood shops. He emphasized the fact that the additional shop output necessary to obtain the returns from a variable speed system was only a little over 2½ per cent.; if that amount of increased output was obtained with a system of speed control, the additional cost was fully justified. He was positive that far more than 2½ per cent. was obtained because of the convenience of speed changing on the machines. The machine attendants acquired the habit of *changing speeds to suit the work*, and thus secure the maximum output of machines. He considered speed control one of the most valuable factors obtainable in a shop. He also put the question of individual driving squarely "up to the machine tool builders." If machines were built for the direct application of motors at the same price as for belt connection, it cost no more for motors than for belts, shafting and accessories. Tools for variable speed motors (not for expensive gear changes) should be no more expensive than belts and accessories. Tools which would cost $250 or more should be so constructed. [This is a new view of individual driving which is as important as it is radical.—EDITOR.] The speaker was strongly in favor of the four-wire system. Four wires cost little more than three after the conduits were in. Lighting by two 120 volt arc lamps in series was entirely satisfactory at Collinwood. He did not believe that commutation would be satisfactory in large ranges of speeds with field control on what he called the standard motor. The three-wire system did give a constant horse power over the entire range. This had been considered necessary, but the speaker was not sure that it was. For example, it required nearly three times as much power to double the speed of a planer, and further information was necessary. For a load factor, he had found 30 per cent. sufficient to cover actual practice.

Locomotive Front Ends.—Mr. Vaughan spoke of the AMERICAN ENGINEER tests as establishing the conditions of the "front end" of a locomotive of the size of that at Purdue University as thoroughly as they ever would be. This was a good basis for further work, applying the results already obtained to larger engines. This would not be as difficult or

elaborate as the earlier work, and the committee wished to be continued to conduct laboratory tests on a larger engine. Mr. F. H. Clark (C., B. & Q.) reported in general terms the results of a road trial of the formula given in the conclusion of the report. This work showed that the engine steamed rather more freely with the larger stacks. Mr. Vaughan also reported on road tests on locomotives with 54 and 74 in. front ends, in which it was found that the formulæ seem to apply to larger engines. The road tests were not yet completed, and the report next year will probably be of far greater value than any which can be given now. Mr. Quereau believed that laboratory tests only could give conclusive results. He believed the work to be in good hands with promise of good results. The committee was continued. Before the vote was taken a graceful tribute was paid the American Engineer by Professor Goss for its service in connection with the conduct of these tests.

Standard Pipe Unions.—This committee recommended that the association should appoint a delegate to attend the convention of the National Association of Stationary Engineers, to co-operate with that organization with reference to this subject. Instead of doing this, the association at once *adopted* the standard which was presented last year, thus settling the question at once as far as this association is concerned.

Ton-Mile Statistics.—This brief report will be presented in abstract. It showed that the usual mileage allowance for switch engines was about twice too high. Mr. Fowler went into the history of this subject, showing that the present unit was the result of averaging a number of guesses. He desired to have the work of the committee continued to include tests, by a convenient recording dynamometer, to secure data as to the actual work done by switch engines. Mr. Quereau spoke strongly in favor of ascertaining facts as to the cost of operating this equipment and thought it wrong to perpetuate the practice of guessing the mileage. He would like to use a ton mile basis in order to show what switch engines cost in terms of work done, but did not know how to do this. If this equipment costs 30 cents per mile it was well to know it. The result of a long discussion was a vote to continue the committee for positive recommendation next year after conference with the American Railway Association.

Mr. L. R. Pomeroy presented an interesting discussion with reference to the state of the art in the subject of steam turbines and their advantages over reciprocating engines.

The following officers were elected: President, W. H. Lewis; first vice-president, P. H. Peck; second vice-president, H. F. Ball; third vice-president, J. F. Deems; treasurer, Angus Sinclair.

After this action this very successful convention adjourned.

MASTER CAR BUILDERS' ASSOCIATION.

Thirty-seventh Annual Convention, Saratoga, June 29 to July 1.

The convention was opened by the president, Mr. J. W. Marden, with what appeared to be the largest attendance in the history of the association and larger than that of the Master Mechanics' Association. The convention was addressed by Mr. George H. Daniels, of the New York Central. Mr. Marden's presidential address began with a review of the unprecedented commercial condition of the country. Referring to the accomplishment of freight-car interchange, the speaker said, "Progress should be our watchword." The most important work at hand was the adoption of the standard car. A high tribute was paid to the association in its administration of car interchange by a statement of the fact that but sixteen cases had been submitted to the Arbitration Committee during the year. The speaker also reviewed the papers and reports individually.

The report of the secretary showed a total membership of 534, and an increase of 119,923 cars in the equipment represented. The funds on hand amounted to $6,883.29, with no unpaid bills.

Mr. E. A. Moseley, of the Interstate Commerce Commission, in an address presented an argument for interchangeability in couplers, basing it upon a legal case involving a Miller and M. C. B. coupler between a locomotive tender and a dining car. The new law would cover such cases, and the safety-appliance law would soon cover all cars. He quoted figures to show the effect of the safety-appliance law in decreasing the injuries and fatalities in railroad service. A more rigid compliance with the law was being demanded by organizations of employees, and the speaker desired to direct the attention of the association to this fact and to the necessity for keeping equipment up to the highest standard as to safety appliances. September 1 would see a radical change in the law which will compel proper maintenance in this respect. Incidentally, Mr. Moseley gave deserved credit to Mr. M. N. Forney for a large part in the development of construction and methods to reduce the dangers to which trainmen are exposed. Mr. Moseley wished to include in the safety-appliance law the standard and recommended practices of the association, and hoped this might be accomplished. It was ordered that a committee be appointed to confer with the Interstate Commerce Commission upon safety appliances, and that this committee be continued from year to year.

TOPICAL DISCUSSIONS.

Four-wheel vs. Six-wheel Trucks for Passenger Cars.—Mr. W. P. Appleyard stated that the New York, New Haven & Hartford was running 60-ft. passenger cars on four-wheel trucks with satisfactory results, the cars weighing from 70,000 to 80,000 lbs., and had 4¼ by 8-in. journals. Satisfactory experience with four-wheel trucks was reported from the Santa Fé and the Jersey Central. They seemed to be satisfactory where used.

Ideal Arrangement for Repair Shops of Small Capacity.—Mr. G. N. Dow described the repair-shop facilities on the Lake Shore at Ashtabula, Ohio, where 2,500 cars are handled per day. This plant will be referred to again.

Modification in Height of Drop for Testing Axles.—Mr. E. D. Nelson showed that the M. C. B. drop tests are too severe for iron axles, which had led to complaints from manufacturers. He had found by investigation that comparatively few iron axles were made outside of railroad shops, and did not recommend a change. He thought it advisable to secure uniformity in axles of iron and steel. The discussion showed that it was becoming difficult to obtain scrap axles; that while they would not stand tests as well as steel, they seldom failed in service. This discussion may perhaps be considered as the "last wail" of scrap-iron axles as far as discussions before this association are concerned.

Steel Cars.—Mr. A. L. Humphrey opened the discussion by predicting that in a few years no cars other than steel will be built. He had found composite cars of steel and wood as satisfactory as all steel cars as to repairs. The all steel car was better able to withstand wrecks. He had found more corrosion in the case of composite cars. A steel frame box car was considered a possibility. The speaker believed that the time of the steel car had arrived. Attention was needed to provide adequate draft gear and prevent corrosion. Steel cars were here to stay, and corrosion must be provided for. The speaker considered corrosion as vitally important. Mr. Sanderson made a point of the fact that composite cars need not weigh more than all steel cars.

Mr. Seley spoke favorably of composite construction. He thought it proper to lay aside the theory that the underframe should carry all the load. He believed it desirable to utilize the side framing as trusses to aid in carrying the load. He cited the weights and experience on the Norfolk & Western with composite construction. (This series of cars has been illustrated in this journal.—Editor.) The weights and performance were satisfactory. The trussed steel side frame

box cars on that road had not been at the shop for repairs. Steel frames for box cars were also considered necessary in order to provide proper strength for the end construction. The only steel underframe car the speaker would build would be a flat car. His preference was distinctly for composite construction. The cost, the proportion of revenue load, the labor required for repairs were all favorable to that construction. The speaker referred to the report of cost of repairs of composite cars on the Norfolk & Western as stated by Mr. W. H. Lewis in our June issue. Mr. Seley had found no serious corrosion in the framing of Norfolk & Western cars after two years' service. Painting was important. He presented the claims of the composite car from the standpoint of successful and entirely satisfactory practice and based his opinion upon experience with a series of designs of his own. These facts were not as plainly stated as this, but the opinions are well founded and well and definitely supported by experience.

Mr. Ball wished to see the association go on record in favor of steel members in underframes to take care of buffing and pulling stresses. Mr. Bentley did not believe corrosion a serious matter. His experience covered 16,000 steel cars. Mr. McIntosh said that the exterior surface of cars could be protected from corrosion by painting, and the inside would take care of itself. He considered this question a "bugbear." Mr. Mendenhall said that it would pay to build steel cars if they were to be thrown away after five years, because of the additional carrying capacity.

INDIVIDUAL PAPERS.

A Review of Decisions of the Arbitration Committee, an independent paper by G. L. Fowler.—The record of the work of this committee for twenty-four years is characterized as "an unbroken record of consistency, equity and justice." The author of the paper pays high tribute to the committee, to its members and to the association for the high-minded administration of the difficult work of arbitration, which had rendered possible the present interchange methods. The paper analyzes the decisions of the more than 600 cases ruled upon and discusses the underlying principles involved. These center about the defect card as an authorization for making repairs, the principle of inspection for safety, the responsibility of owners, the basis of repairs as a courtesy and not a money-making possibility, the use of wrong material and other well-known tenets of the rules. One effect of the paped will be an awakening of appreciation of the admirable work of the arbitration committee, another will be a better understanding of some of the principles mentioned.

The Metric System.—Mr. Sinclair read the same paper before both associations. This has already been mentioned in the report of the discussions at the Master Mechanics' Convention. The resolutions offered in the paper were adopted after a very brief discussion, and the subject disposed of. The metric system was emphatically "turned down" by both associations.

DISCUSSIONS OF COMMITTEE REPORTS.

Tests of M. C. B. Couplers.—This report described the new coupler drop testing machine. A separate knuckle test was recommended, and a revision of the coupler specifications proposed. In order to increase the strength of coupler changes in the contour seemed to be necessary, and it was recommended that this be done by progressive changes. The committee favored the "improved lines" of the Buckeye Malleable Iron & Coupler Company.—This discussion, and in fact, the report itself, was chiefly concerned with the construction of couplers and attachments for pulling cars out of sharp curves when the knuckle slots and pin-holes are abandoned. Several speakers argued for a more perfect fit between knuckles and couplers. A machine job instead of rough fitting was desired. The holes should be drilled and the pins turned. The committee recommended an increase in deflection in the guard arm test. The minimum weight specified in previous specifications was omitted. A new jerk test was suggested, which would permit of submitting the test to one instead of two couplers at a time. The committee wished to secure a satisfactory unlocking device with a rod to be operated from both ends of the end sills and wished to continue efforts in this direction. The solid knuckle problem was believed to be solved by the device suggested by the committee and the immediate abolition of the knuckle slot and pin-hole was urged. The recommendations of the committee were ordered submitted to letter ballot.

Outside Dimensions of Box Cars.—This committee submitted drawings of proposed construction of a standard car (above the floor framing) asking for criticisms. The design was made to correspond with the inside limits of the American Railway Association and the outside dimensions recommended last year. In the discussion several members expressed the opinion that end construction of cars were almost always too weak. Very heavy construction should extend up at least 2 feet above the floor. The committee explained that the drawings were submitted merely to secure discussion. A discussion of details of construction of a standard car has actually begun. On this fact the association is heartily congratulated. The committee was continued for further report next year upon the design of car framing above the floor.

Standard Pipe Unions.—This report is the same as that presented to the Master Mechanics' Association, being a joint paper submitted to both associations. Mr. Quereau was the chairman of both committees. The recommended standard was ordered submitted to letter ballot.

Steam and Air Line Connections.—Mr. Bell explained the reason for recommending 2-in. steam lines. At times from 15 to 20 minutes is required to get steam through long trains at terminals where engines are changed, and this would be reduced by the use of the larger pipe. A hose larger than 1⅝ in. inside diameter was not considered desirable. An opening of 1½ in. through the gaskets of couplings was recommended. Mr. Seley characterized the report as marking a radical reconstruction of practice in car heating by steam. He pointed out the fact that construction difficulties must be met. The recommendations of the committee were approved and the questions of location of connections and size of couplers were submitted to letter ballot as a recommended practice.

Pedestal and Journal Box for 5 by 9 in. Journals.—The report was at once referred to letter ballot as recommended practice.

Standard High Speed Foundation Brake Gear.—This report will appear in abstract. Mr. E. M. Herr paid the committee a compliment upon the report. Mr. Seley thought it entirely feasible to make some of the parts of malleable iron without increasing weight. The recommendations were submitted to letter ballot as recommended practice.

Proper Design and Construction of Tank Car Equipment.—This report was not printed in advance. It contained a statement of the elements of safe construction, covering the construction and fastenings of tanks and frames and the provision of safety valves. It showed tank car practice to be in a very unsatisfactory condition and offered recommendations and plans for construction. This was an admirable report and very interesting. It included tests on safety valves to provide relief from dangerous pressure. The report was indorsed and ordered submitted to the American Railway Association. It will undoubtedly result in putting tank car practice in good shape. It was stated that the Union Tank Line would go into the improvement of its equipment in accordance with the recommendations of this extremely able report.

Supervision of Standards and Recommended Practice.—This report presented a few changes of minor importance. It suggested a change to make Sheet 19 consistent with the corresponding text, and a change of reference figures on the air-brake defect and to letters. The committee entered a protest against unnecessary changes. The recommendations of the committee were ordered submitted to letter ballot.

Side Bearings and Center Plates.—The conclusions of this report will be presented next month. Upon a motion, the center plate proposed by the committee was referred to the committee for complete data as to contour.

Draft Gear.—This committee presented a voluminous report of tests last year, and was instructed to report upon the service of draft gear this year. A record of service has been inaugurated, but it was thought necessary to wait for at least two years before attempting to compare information with reference to cost of maintenance. Therefore, no attempt was made to submit suggestions to be adopted as recommended practice. The committee was continued for report next year.

Cast Iron Wheels.—Mr. Waitt considered it very important to secure a conference between the committee and the manufacturers of wheels. Mr. Linstrom criticised the designs of the wheels. The committee was continued to confer again with the manufacturers for further report next year.

INTERCHANGE RULES.

The leading question involved the following suggestion from the Western Railway Club with reference to Rule 2 of the Interchange Rules:

"*Empty* cars offered in interchange must be accepted if in safe and serviceable condition, the receiving road to be the judge in cases not provided for in Rules 3 to 54, inclusive. *Loaded cars offered in interchange must be accepted. If not in safe and serviceable condition, the receiving road to transfer the load at its expense.*"

The question was generally considered as being beyond the jurisdiction of the association. A roll call vote on submitting the question of letter ballot was decided adversely. The decisions, throughout, were in accordance with the recommendations of the arbitration committee. The entire discussion occupied exactly two hours, and no radical or very important changes were made.

ELECTION OF OFFICERS.

President, F. W. Brazier; first vice-president, W. P. Appleyard; second vice-president, Joseph Buker; third vice-president, W. E. Fowler; treasurer, John Kirby.

The convention adjourned.

PERSONALS.

Mr. Arthur H. Fetters has been appointed assistant mechanical engineer of the Union Pacific Railroad, with headquarters at Omaha. He has held the position of chief draughtsman for several years.

Mr. J. A. Doarnberger has been elected president of the International Railway Master Boiler Makers' Association. He is master boiler maker of the Norfolk & Western Railway at Roanoke, Va.

Mr. E. B. Thompson has been appointed master mechanic of the Minnesota and Dakota division of the Chicago & Northwestern, with headquarters at Winona, Minn., having been transferred from the Iowa and Minnesota division at Mason City, Iowa. He is succeeded at Mason City by Mr. William Hutchinson, transferred from Winona.

Mr. J. E. Muhlfeld, recently appointed general superintendent of motive power of the Baltimore & Ohio, has had a remarkable record of promotion. He was born in 1872, and was educated at Purdue University, where he was graduated in mechanical engineering in 1892. His first railroad service was in the shops of the Wabash Railroad at Fort Wayne. After serving as machinist apprentice, locomotive fireman, roundhouse foreman and general foreman on that road, he went to the Grand Trunk in 1899 as master mechanic at Port Huron, and was afterward master mechanic at Montreal. In 1901 he resigned to become superintendent of motive power of the Intercolonial of Canada. In October, 1902, he went to the Baltimore & Ohio as assistant to the general superintendent of motive power, and last February was appointed superintendent of motive power at Newark, Ohio. He was promoted to his present position June 1. He is undoubtedly the youngest official ever appointed to a position of such responsibility.

Mr. W. H. Marshall has been appointed general manager of the Lake Shore & Michigan Southern Railway and the subsidiary lines. Since the death of Mr. P. S. Blodgett last October Mr. Marshall has been carrying the responsibilities of management as general superintendent. Mr. Marshall has had a very unusual career. He began as machinist apprentice in the Rhode Island Locomotive Works and without the advantages of a technical school training became mechanical engineer of the works. After spending about eight years in newspaper and consulting engineering work, he entered railroad service May 1, 1897, as assistant superintendent of motive power of the Chicago & Northwestern. This was six years ago. Since that time he has been superintendent of motive power and general superintendent of the Lake Shore. His success is due to ability, good judgment and strong personal traits which enable him to surround himself with efficient and loyal subordinates. This journal announces his appointment with pride because of his former connection with it. People like to see such men achieve the highest success, because they deserve it.

EDWARD GRAFSTROM.

Those who knew him will not be surprised to know that in the emergency occasioned by the recent floods in Topeka, Mr. Grafstrom took an active part in efforts to rescue those whose lives were endangered, but it was a shock to all his friends to know that after saving 77 people in a small launch he was lost in the river. Mr. Grafstrom was in charge of a boat built in the railroad shops at Topeka for rescue work, and in returning for the last time on June 2 across the river, the boat was caught in the rapid water and capsized. All were saved except Mr. Grafstrom. He was an accomplished mechanical engineer and from natural ability, training and experience was an officer whose loss will be felt when such men are so greatly needed on our railroads. Readers will miss his contributions to this journal. He was a man of wide acquaintance and attractive personality, uniformly courteous and of distinguished appearance. He was a native of Sweden, and though a resident of this country for twenty years, remained a subject of King Oscar, to whom he owed his education. His first position in this country was in the shops of the Pennsylvania at Altoona. In 1886 he went to Columbus, and in 1892 became mechanical engineer under Mr. S. P. Bush, then superintendent of motive power. In 1899 he went to the Illinois Central as mechanical engineer and soon afterward entered the service of the Santa Fe in the same capacity. He held this position at the time of the accident in which he sacrificed himself in an effort to save others.

The nobility of his act and his response to the appeals of those who were in the greatest danger for days are impressive and altogether fine. He was lost in the culmination of his character.

His friends have inaugurated a memorial fund to which the members of the Master Mechanics' and Master Car Builders' Associations and others will have an opportunity to contribute. Mr. S. P. Bush of the Buckeye Malleable Iron & Coupler Company, Columbus, Ohio, is treasurer. He was associated with Mr. Grafstrom for many years and that the fund may be a large one is the hope of all of Mr. Grafstrom's friends and associates.

Contributions may be sent to this journal for transmission to Mr. Bush.

An efficiency of 1.6 per cent. in a mechanical and chemical process is very low and it at once suggests a great opportunity for improvement. This is the figure given in the paper by Mr. R. P. Bolton, before the American Society of Mechanical Engineers, as the efficiency of the combined system of apparatus from furnace to load in operating the passenger elevator system at Macy's department store in New York City. This 1.6 per cent. is the proportion of heat in the fuel represented by the live load traveled. The elevator system is hydraulic.

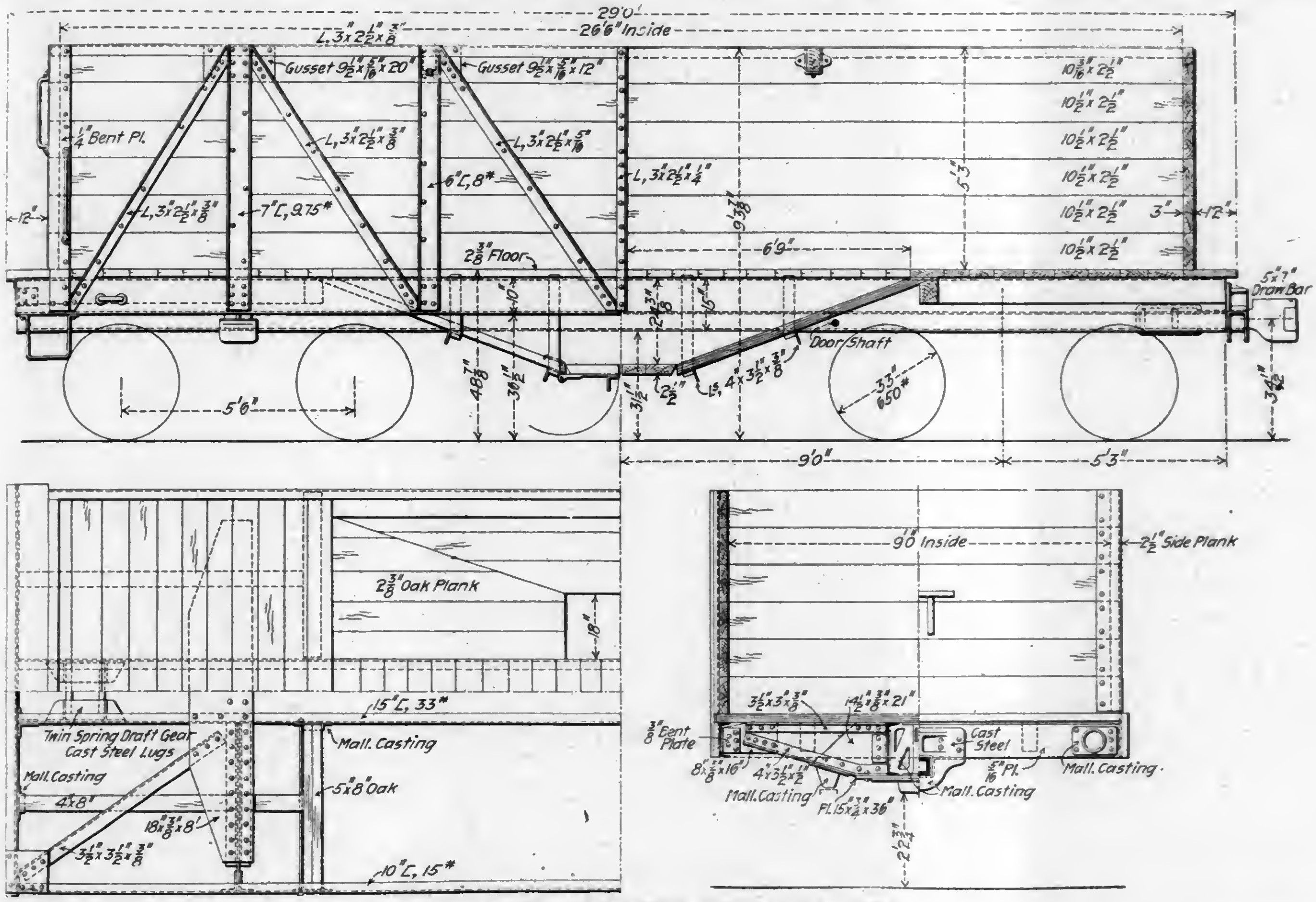
40-TON COMPOSITE GONDOLA COAL CARS.

WITH TRUSSED SIDE FRAMES.

Having had occasion to design a steel frame coal car on the lines of the Pennsylvania class G-N gondola, similar to those in use by the Berwind-White Coal Mining Company, Mr. George I. King, of the Middletown Car Works, has sent a drawing showing how easily steel frames may be applied without changing the general dimensions or the trucks. The steel structure is built into or around the wooden structure with a simple substitution of steel for wood in the sills and sides. Instead of pressed steel side stakes, trusses of angles, channels and plates are used. These help to carry the load. The center sills are 15-in., 33-lb. channels; the side sills are 10-in., 15-lb. channels and the end sills are 5-16-in. plates. The drawing shows the construction of the bolsters and side frames and the sizes of the members are indicated. To support the hoppers, 3 by 1 in. straps are used and the floors of the hoppers are stiffened by 4 by 3½ by ⅜ in. angles.

This is not intended as a finished design, but a study in the application of steel in this way. Mr. King believes that the steel frame offers a good many advantages over all steel construction for coal carrying equipment, particularly from the standpoint of corrosion. He is inclined to think that the life of the all-steel car for coal will be much shorter than originally estimated, for reasons which are inherent in the nature of the service. Steel frames with wood sides and floors can be built for less cost than all steel cars and the elements of the structure supplying strength and durability are protected from the scouring action of the coal. If properly painted, when first put in, these members should last much longer than the all-steel construction. In this he agrees with those who were responsible for the adoption of composite construction on the Norfolk & Western. In fact, Mr. King says: "The general type of frame follows the lines laid down by Mr. Seley, formerly of the Norfolk & Western. I am frank to say that nothing better has yet come under my observation."

The Norfolk & Western construction was described in this journal in June, 1899, page 187; April, 1900, page 100; February, 1901, page 42; May, 1902, page 140 and June, 1902, page 181.

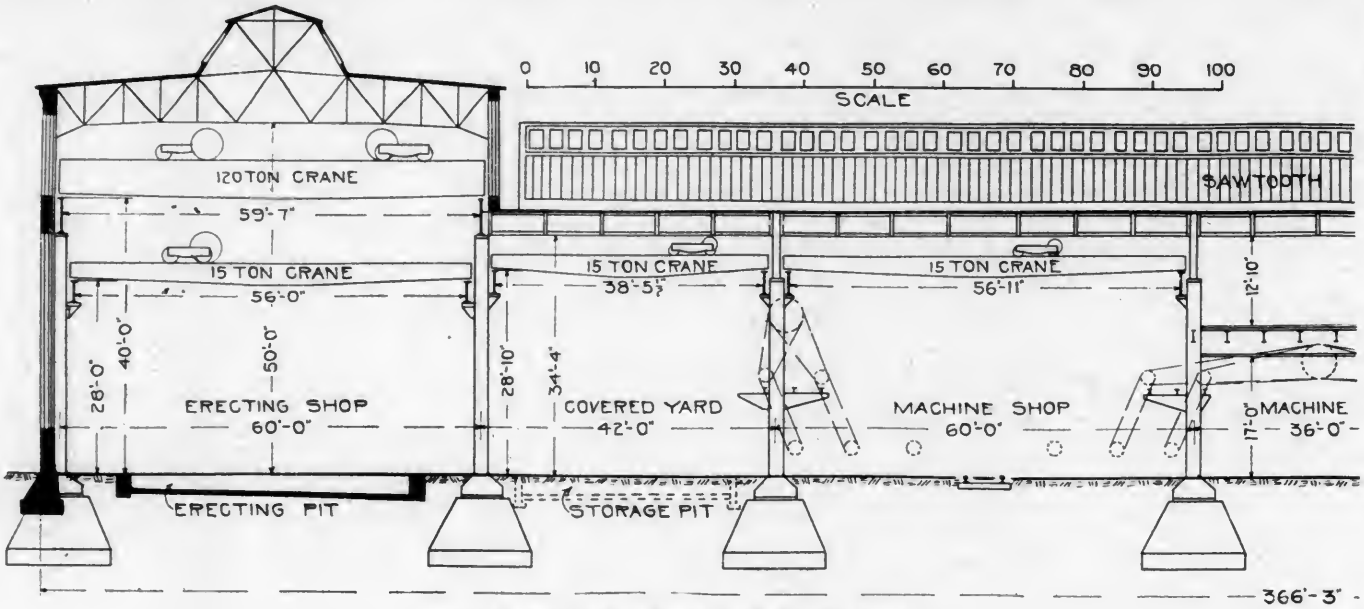


DESIGN FOR A 40-TON COMPOSITE GONDOLA COAL CAR.

A FILLET TOOL FOR CAR AXLES.

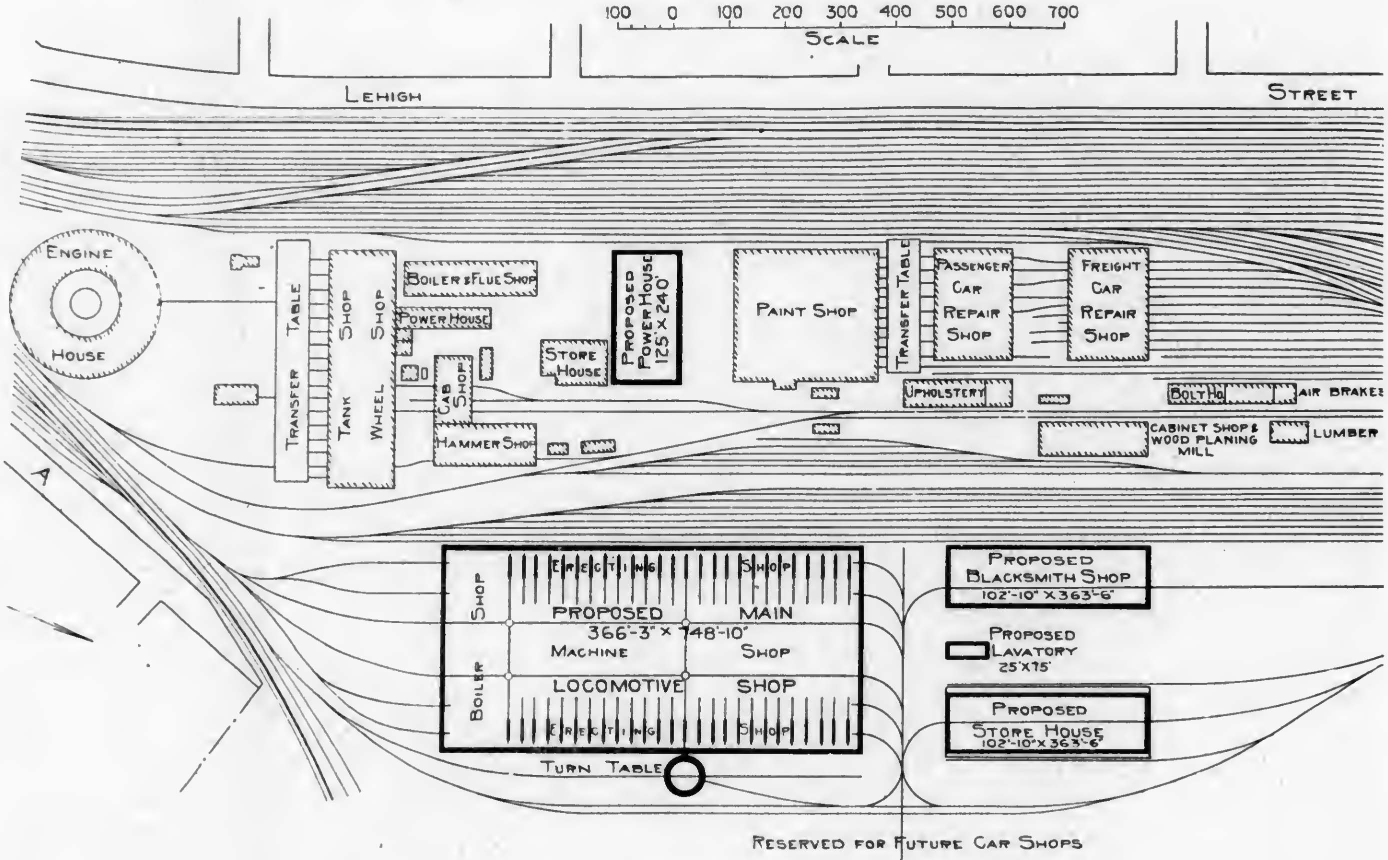
This device was developed by Mr. R. D. Fildes, foreman of the car department machine shop of the Lake Shore & Michigan Southern Railway at Englewood, Ill. It is used to turn up journal fillets when they are worn and the journal itself does not require turning. If the journal is worn out of true, even slightly, the fillet cannot be turned up on the lathe without turning up the whole journal as well. This device goes in the lathe and the small tool in one of the halves of the shell, which closely resembles a pair of bearing brasses, is used to turn the fillet, making it true with the journal. The engravings show the shell, the key for holding the two parts in place and the device put together in the lathe ready for service.

VIEW OF THE FILLET TOOL IN ITS GUIDING SHELL AND METHOD OF APPLYING IN THE LATHE.

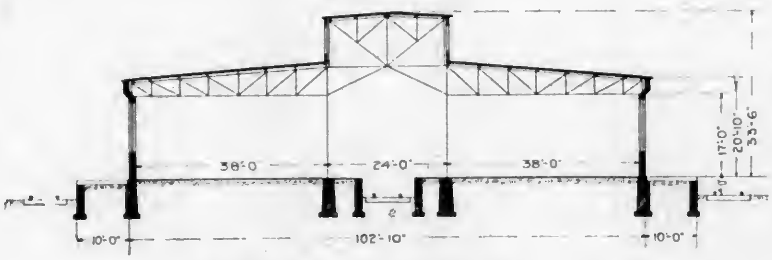


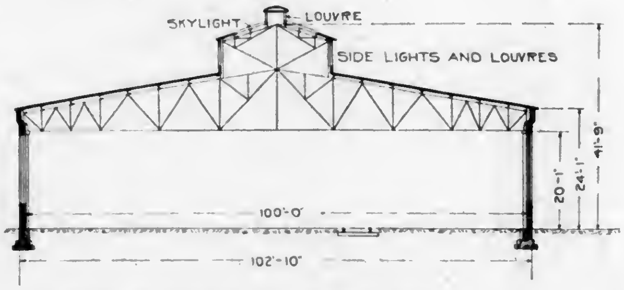
HALF CROSS SECTION OF LOCOMOTIVE SHOP.

PROPOSED NEW SHOPS AT SAYRE, PA.—LEHIGH VALLEY RAILROAD.



GROUND PLAN OF THE PROPOSED NEW LOCOMOTIVE SHOPS.

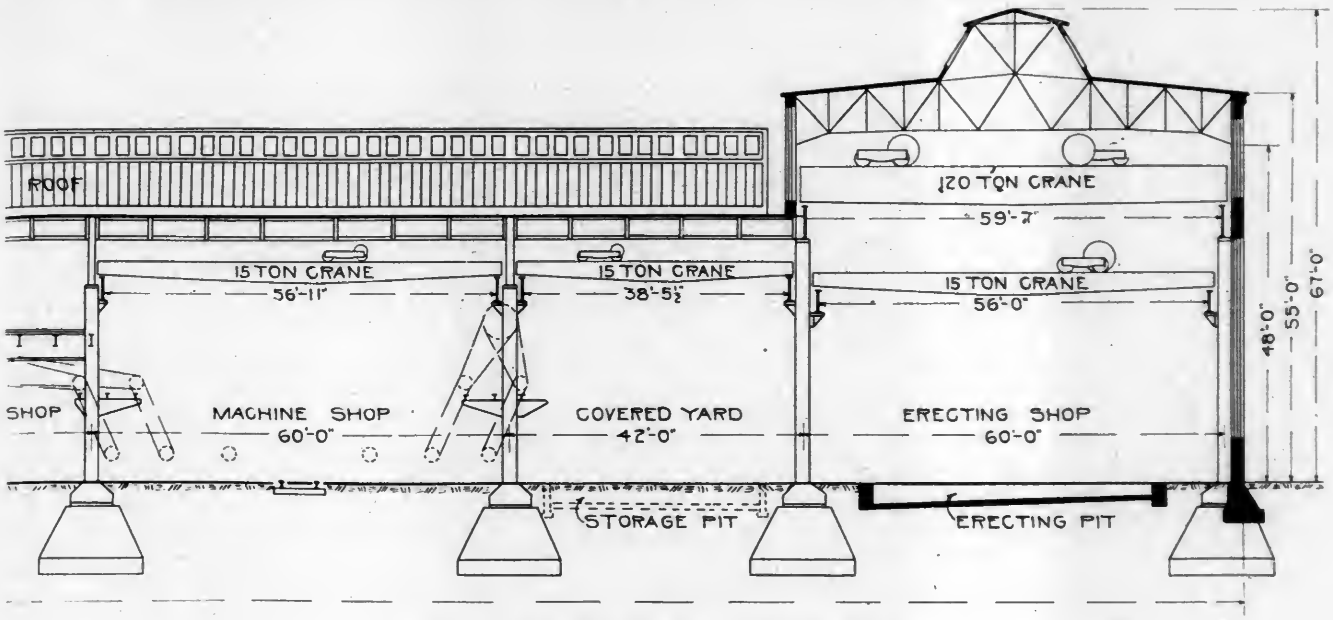




CROSS SECTION OF STOREHOUSE.

CROSS SECTION OF BLACKSMITH SHOP.

PROPOSED NEW LOCOMOTIVE SHOPS AT SAYRE, PA.—LEHIGH VALLEY RAILROAD.



HALF CROSS SECTION OF LOCOMOTIVE SHOP.

PROPOSED NEW LOCOMOTIVE SHOPS AT SAYRE, PA.—LEHIGH VALLEY RAILROAD.

PROPOSED SHOPS—LEHIGH VALLEY RAILROAD.

At Sayre, Pa.

A brief statement of the plan for the new shops of this road at Sayre was made last month. Mr. Berg has furnished drawings of the proposed ground plan and sections of the principal buildings, which are presented as indicating the interesting character of the main building. This arrangement gives unique crane service, as shown by the section.

The roof construction of such a building presents an interesting problem. Over the erecting shop bays a monitor with inclined sides will furnish light and ventilation. The roof intermediate between these bays will be of saw-tooth construction and will be supported by columns, as indicated. These columns will furnish supports for countershafting and thus permit of keeping the belting out of the way of the cranes.

The locomotive shop buildings will be the first to be completed. The main locomotive shop will have an erecting shop with 48 erecting pits, divided into east and west sections, each section being 60 x 627 ft. Between the two sections will be the machine shop, 156 x 627 ft. At one end of the building will be the boiler shop, 121 x 366 ft. The machine shop will be divided into two bays, each 60 ft. wide, and a central bay 36 ft. wide. The central bay will have a gallery over it for the heating apparatus, toilets, lavatories, lockers, etc. The space under the gallery will be utilized for small machinery, bench work, link and motion work, tool room, etc. Between each erecting shop and the machine shop there is a 42-ft. space, 627 ft. long, called a covered yard. This space is to be used as an overflow storage ground for both the erecting and machine departments, making a conveniently located space inside the building in place of an open yard outside the building for storage of dismantled parts and miscellaneous materials. In this space will be located the storage pits, lye vats, tire shrinking platforms, etc. This plan gives the result that all locomotive repair work, with exception of blacksmith and forge work, will be conducted in one large building, with overhead cranes serving all important points.

The erecting shop is designed as a transverse shop with heavy overhead traveling cranes for transferring engines over others standing on the pits. This system corresponds to the practice of the most recently built large locomotive repair plants of the Philadelphia & Reading, at Reading, Pa.; the Lake Shore & Michigan Southern, at Collinwood, O., and the Pittsburgh & Lake Erie, at McKees Rocks, Pa.

The capacity of the overhead cranes in the erecting shop will be 120 tons on the upper level and 15 tons on the lower level. The overhead cranes in the machine shop and covered yards will have a capacity of 15 tons. All the cranes will extend into the boiler shop.

The details of the power plant and machinery have not been finally determined. All power transmission and lighting will be by electricity. The machinery in the machine shop will be driven by a combination of individual and group drives.

Ample provision has been made for future extensions and additions, and the new buildings will be grouped in connection with the present buildings so as to give a practical and economically working shop plant. The buildings will generally have concrete foundations, brick walls, steel frame and roof trusses, covered with slag roofing laid on armored concrete. The floors will be generally wood on concrete beds. In the higher grade buildings the top floor will be maple, in other buildings yellow pine. The blacksmith shop and part of the boiler shop will have cinder floors. Side windows will have plain glass and in the main locomotive shop factory ribbed glass. Roof lights and monitor lights will be wired glass. The heating of the main shop will be by a hot air blower system, the fans being run by motors and the heater units supplied with exhaust steam from the power plant. All other buildings will be heated by direct steam radiation. All pipes and main wiring will be conducted from the central power plant through an underground tunnel and ducts to the various buildings. Proper provision will be made for water supply, fire service, drainage, sewerage, sanitary arrangements, etc.

The design, construction and equipment of the new shops will be in charge of Walter G. Berg, chief engineer, and H. D. Taylor, superintendent motive power.

The British Westinghouse Company are building for the Metropolitan District Railway of London four turbo alternators, each having a normal capacity of 5,500 kw. and designed for 50 per cent. overload, which will give a maximum capacity of 8,250 kw., or approximately 11,000 h.p. each. These will be the largest turbines ever built, and no larger single-cylinder engines have ever been constructed. In fact there are few engines of any kind having greater power. The space occupied by each unit will be 29 x 14 x 12 ft. high. The turbines will operate with steam at 165 lbs. per square inch and will make 1,000 revolutions per minute.

THE PIECE-WORK SYSTEM FROM A PIECE-WORKER'S STANDPOINT.

By H. B. Kepner.

(Concluded from page 233.)

It is not the desire nor purpose of the promoters of piece-work to pay less than any work is worth at any time. As a master mechanic of considerable note and experience recently instructed his inspector not to be obstinate with his men and "in any dispute of a small difference of, say, three or four cents, though you may be sure he is not entitled to it, yet if he believes he is, pay him and always in a matter of doubt, give the workman the benefit of the doubt."

Does this instruction from the promoters of piece-work look as if they desired to oppress or grind down the workman? And do you think that his men would wilfully take advantage of his fine sense of justice, even to the amount of three or four cents? I should answer, no. For being a workman of long association with workmen, I know there is too much of genuine worth in the make-up of even the most ordinary shop man to ignore such kindness. And would you censure the master mechanic as being partial towards the interests of the men? Again I would answer, that he is most loyal to the interests of his employer when he is most solicitous as to the welfare of his workmen. For he is thereby meriting their highest esteem and drawing from them the best there is in them, both in service and manhood.

But I would be digressing to go further than this, to illustrate that it is illogical to expect less fair treatment under the piece-work system than is received under the day-work system. When the workmen are once convinced that they are to be treated with justice in every respect, the dread of piece-work will vanish and the men will feel freer to put forth their best efforts and quit worrying about the reduction of prices, but instead will be ready with suggestions as to their adjustment until, as water seeks its level, prices will gradually become fixed at a fair and equitable standard. The men themselves will assist in regulating prices, conceding to adjustment of prices that are too high as often as the inspector may, in cases where prices are too low.

A case recently came under my observation where an inspector, working upon the plan of starting in on low prices, undertook to install piece-work into a department of wood-workers and set a price at about half of what the foreman of that department asked, and rather than concede to the workman's reasoning, declared that the work was done for a certain amount at an Eastern factory and that he would only pay so much here, resulting in a strike and failure to establish piece-work in that department.

Now, in introducing piece-work into a shop, it is preferable to retain the old force of workmen and avoid unnecessary clashings with them, if possible, though they may sometimes seem to jump at conclusions and appear unreasonable. It is not merely of choice that they are obstinate in their views, but through distrust, which is strengthened by every decision on the part of the inspector or foreman, contrary to their views or their rights, as they understand them.

A large body of men who have not the time or opportunity, or possibly not the inclination, to give the subject the thorough investigation it deserves may be influenced and led by the views expressed by one of their number, though he may have little or no ground for his theories and may be incited through prejudice to agitate his fellow-workmen to act in a united effort to prevent its adoption.

And yet, after a careful study and a thorough trial, I have seen the most obstinate change their minds, and men who had most vigorously opposed piece-work became convinced of its fairness. They lost all fear of dishonesty on the part of its promoters and just as vigorously protest against a change back to the day-work system.

Several years ago, before the Burlington roads adopted the system, when piece-work was being debated, my own brother pronounced it to be the only just method of compensating labor and predicted its almost universal adoption in no distant future. When I attempted to defend the common day-work system, I was surprised at the difficulty I experienced in finding arguments commendatory to the system. I admit I was successfully floored, against my most ardent contentions, and wondered why it was. The system is still being debated and is yet in its infancy.

Price lists are being established, though under many difficulties, and much uncertainty as to fair prices is bound to exist for some time yet, until all branches of shop work may be properly classified and correct estimates of time and labor derived through various experiments and observations.

The task of establishing prices is an important one and should be met fairly and squarely from every standpoint. The rates paid in Philadelphia, for instance, should of necessity be a little closer than they are out here in the West, for are not day rates less there than they are here? Then again, the prices there have been fixed after years of experimenting and developing facilities for doing the work until their prices may look incredulously low and men out here will conclude they are to lose if they submit to them, and probably with the present facilities they would. But rather trust the workmen who make an honest effort to demonstrate the most reasonable time required to do the work and pay accordingly. If too great a difference exists investigate the cause, compare facilities, remembering that you have just as good men as they have anywhere, and with facilities and conditions the same like results may be obtained.

I believe any body of workmen who are competent and fair can be shown that greater possibilities are open to them under the piece-work system than any other, that they can make more money, and that their employers can always afford to pay them better than they ever did under the day system.

PISTON VS. SLIDE VALVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

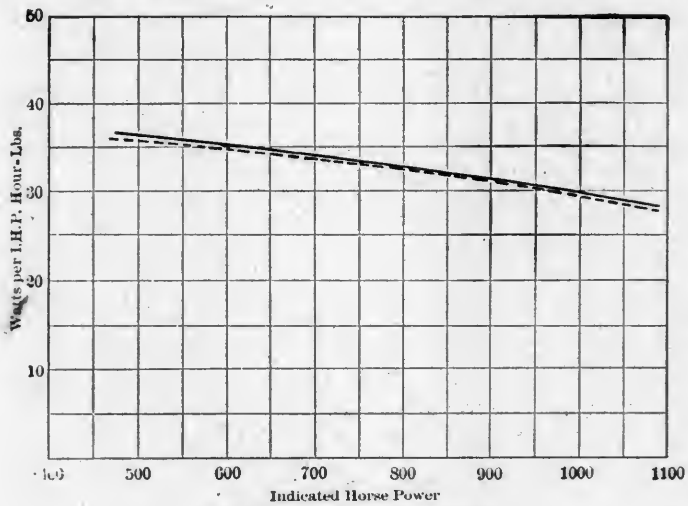
Last October this road conducted an elaborate series of tests to determine the relation of piston and Richardson slide valves with respect to water consumption, 18 tests being made with the piston valve and 20 with the slide valve.

The two engines used were of the 4-6-0 type, identical in every respect as to the valve motion, No. 600 being equipped with the Allen-Richardson balanced slide valve while No. 611 had the direct motion, inside admission, piston valve, the principal dimensions being 20 x 28-in. cylinders, 80-in. driving wheels, weight on drivers 133,000 lbs., total weight 171,600 lbs., heating surface 2,862 sq. ft., grate area 33.5 sq. ft. The tests were made on the Michigan Southern division—143 miles long—Elkhart to Toledo and return, and on two regular mail trains, nothing out of the ordinary as to speed or methods of firing in any way being attempted, as the tests were made to get results from ordinary every-day practice. Two engine crews were practically all that were used during the whole test, the tonnage and speed of the trains, also the weather, did not vary much from day to day, and everything was conducive to an accurate test. (The locomotives were described in The American Engineer, November, 1899, page 343.)

To determine the indicated horse-power indicator cards were taken every minute throughout the runs. The speed was taken by a revolution counter which was checked by mile posts and found correct. Water measurements were taken by gauges placed in the corners of the tank, the readings being corrected to give the depth of the center of gravity of the surface of the water. By subsequently calibrating the tank for each inch of height, on track scales, this method of measurement was checked. Coal was weighed on the tender by track scales. Eighteen tests were made on engine No. 611, these being equally divided on each side of the engine, 20 runs being

made with the other engine. No allowance was made for the steam consumed by the air pumps, the loss at pop valves or water lost at the injector overflows. The indicated horse-power was averaged as given in the accompanying table. For several of the runs the cylinder tractive power was plotted, and the total foot-pounds of work were found from the diagram, but it was found to vary so little from the average indicated horse-power that the latter was used in subsequent tests. The indicated horse-power was taken only for the time during which steam was applied.

The results are clearly shown in the diagram, illustrating the relative efficiency of the two engines far better than the tables. The dotted curve on the diagram is that of engine No. 611, with the piston valves. These curves are interesting because they show remarkably uniform results from road tests, and there is little doubt of the accuracy of the curves drawn to represent the average results. The piston valve engine is



DATA FROM INDICATOR CARDS.

(DOTTED CURVE REPRESENTS THE PISTON-VALVE ENGINE, AND SOLID CURVE THE SLIDE-VALVE ENGINE.)

slightly more economical than the one with slide valves, but by amounts varying only from 1 to 1½ lbs. of water per h.p. per hour, say 3 to 4½ per cent. This is probably due to decreased compression in the piston valve engine which is shown in the indicator diagrams. The indicator diagrams show that the steam line is better maintained on the slide valve engine, the exhaust line being, however, better on the piston valve engine.

The tests are interesting also from the large amount of power developed, each engine having averaged over 1,000 h.p. for the entire distance of 143 miles. The evaporative efficiency is low and the reason for this is not yet determined. The coal burned per foot of grate is high, and it is evident that the work developed is all that could be expected from the engines.

PISTON VS. SLIDE VALVES.

Average Results.

	Piston.	Slide.
Engine number	611	600
Duration of steam in minutes	161	155
Tonnage behind tender	317	327
Ton miles	45,400	46,700
Average speed, deducting stops	50.0	49.2
Ton (miles per hour)	15,400	16,100
Average indicated horse power	838	795
Horse power hours	2,160	1,990
Total coal	13,430	13,600
Total water	68,400	69,430
Water per pound coal	5.33	5.10
Water per horse power hour	31.7	34.9
Water per ton mile	1.51	1.49
Water per ton miles per hour	4.16	4.30
Coal per horse power hour	6.23	6.83
Coal per ton mile	.296	.291
Coal per ton miles per hour	.872	.845
Water per square feet heating surface hour	9.28	9.27
Coal per sq. ft. grate area per hour	143.	162.5
Average tractive pull from cards	5,680	5,480
Average cut off in inches	8.52	7.49
Average opening of throttle	.157	.123

The speed at which any machine tool can be successfully run is limited only by the burning of the cutting tool, and the *greatest production* is obtained by running as near this point as possible.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

VII.

BY C. W. OBERT.

An interesting example of the application of variable-speed gear-drive mechanisms to machine tools is presented in a new series of designs of the milling machines built by the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. The LeBlond Company have recently entirely redesigned their line of milling machines in order to meet the very exacting conditions imposed by the use of the new special heavy-duty tool steels in the great tendency toward increased production. Particular care has been exercised in the new designs to provide sufficient strength in the various parts to withstand the "pull" of the heavy cuts, and two important new features have been incorporated, namely, a double back-gear with a special friction clutch, and a very interesting change-gear mechanism for the feeds.

The feed-change mechanism involves an interesting adaptation of the cone of gears and shifting pinion principle. Unlike other devices for this purpose, which we have discussed, this mechanism has two gear cone arrangements, one of which is adjustable in two directions and the other fixed in position, thus permitting a large number of gear combinations with a minimum number of parts. The arrangement for bringing the movable gear cone into mesh with the fixed cone for the various speeds is of particular interest for its simplicity.

The gear box, an exterior view of which is presented in Fig. 32, is mounted at the rear of the right hand side of the milling machines frame, as shown at F, Fig. 31, for convenience of connecting the drive from the spindle. The drive is through spur gearing, arranged within the frame of the machine and so placed as to deliver power to the driving shaft, S, by meshing with gear, A.

Fig. 33 is a cross-section through the middle of the gear box, F, so as to show the relative positions of the various gears and gear cones, and Fig. 34 indicates diagrammatically the principle of the drive. In the latter drawing the drive is shown passing from the driving shaft, S, through gears, A-*b-a-k-g*-O, to the delivery shaft, T; cone of gears, P, is movable, however, and is thus capable of being placed in any necessary position for the possible gear combinations with fixed cone, Q.

Cone, P, is mounted, as shown in Fig. 33, upon a rocker frame, R, which frame is pivoted loosely upon delivery shaft, T. Gear, g, of cone, P, is arranged so as to be permanently in mesh with a gear, O, which is feathered to shaft, T, and is spanned by frame, R, so as to permit longitudinal movement along the shaft while revolving with it. As will be seen from Fig. 34, eight gear combinations are possible, for which reason eight locking holes are provided on the front of the gear box. Handle, H, of the rocker frame is correspondingly provided with a spring pull pin, which is arranged to drop into a locking hole for each position of proper meshing.

It may be noticed from Fig. 34 that there is absolutely no possibility of any interference, or of double-meshing combinations, in shifting the rocker frame, R. From the way that the movable and fixed cones are arranged in the gear box it is impossible to bring more than one pair of gears into mesh at the same time, so that no guiding arrangement is necessary for the locking handle, H; this is an important feature of this mechanism, in providing against stripping gear teeth.

In addition to the eight speeds thus made available, another eight speeds are provided for by the shifting gear arrangement on shaft, S. By throwing the clutch handle shown on the upper side of the box the pair of gears, A-B, which are mounted rigidly upon a sleeve sliding freely upon shaft, S, may be thrown over to one side or the other, so that either one may drive cone, Q, through corresponding gears, and thus at either a fast or a slow speed. Each handle on the gear box is en-

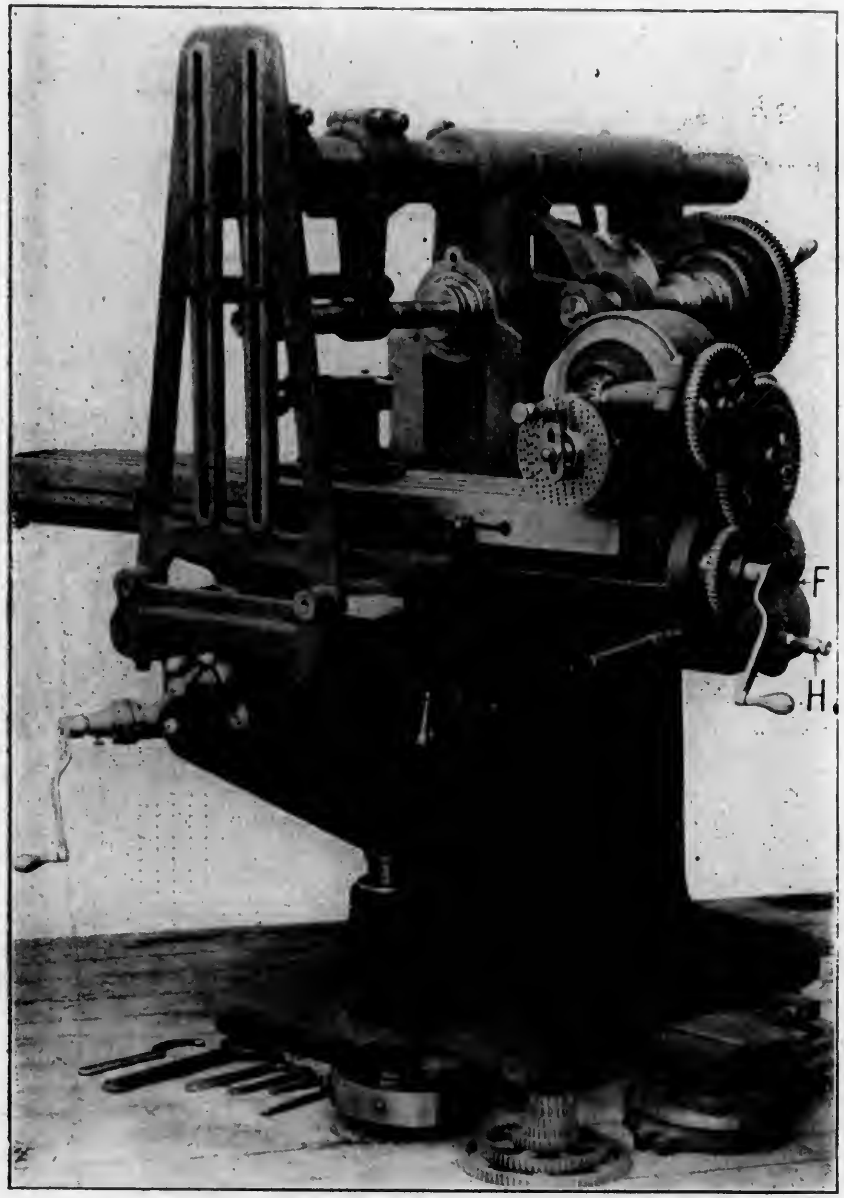


FIG. 31.—GENERAL VIEW OF THE NEW NO. 3 MILLING MACHINE.

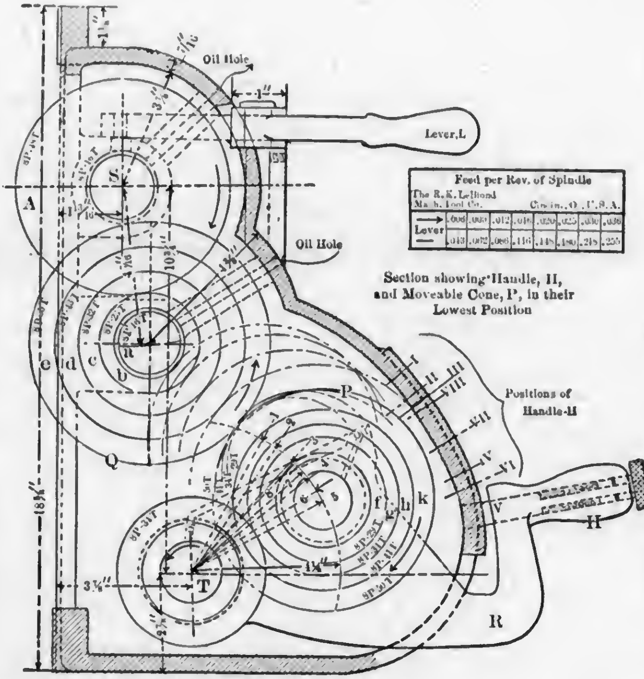


FIG. 33.—CROSS SECTION OF GEAR BOX, SHOWING ARRANGEMENT OF GEAR CONES.

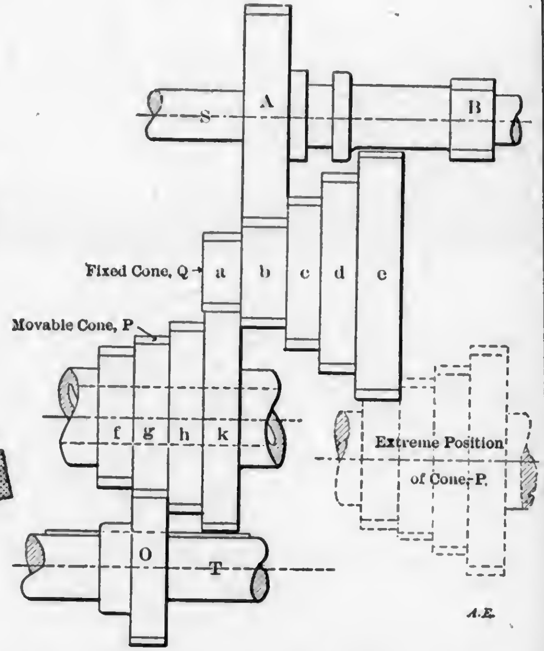


FIG. 34.—DIAGRAM ILLUSTRATING PRINCIPLE OF THE GEAR BOX DRIVE.

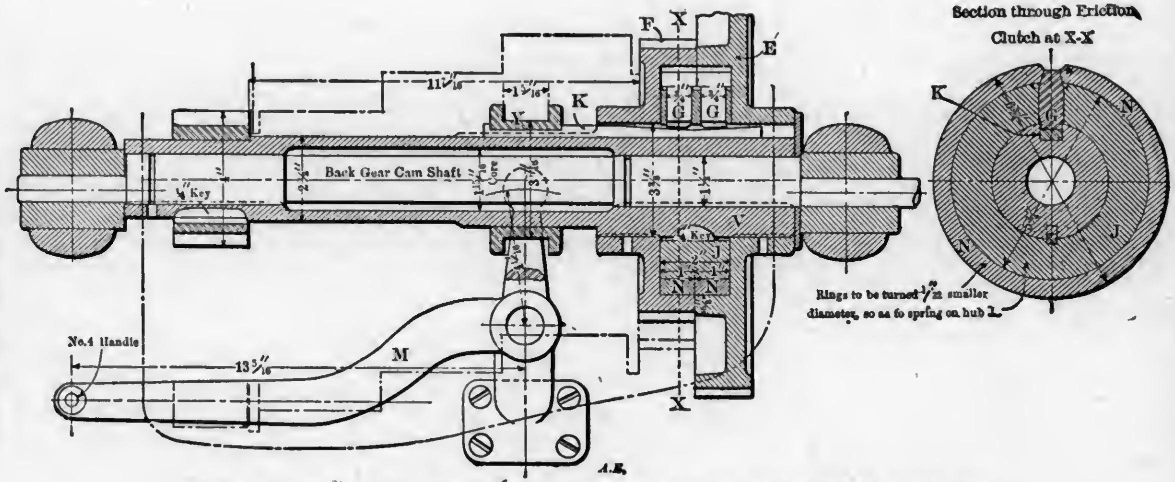


FIG. 36.—DETAILS OF THE FRICTION CLUTCHES FOR THE DOUBLE BACK-GEAR.

NEW UNIVERSAL MILLING MACHINE.—THE R. K. LeBLOND MACHINE TOOL COMPANY.

tirely independent of the other—they may be operated separately or in unison.

The feeds are arranged in geometrical progression, ranging from .006-in. to .225-in. per revolution of the spindle. An engraved plate (reproduced in Fig. 33) is attached to the feed box which indicates the feeds obtained for each position of the handles. When the upper lever is thrown to the right, all the finer feeds are obtained, ranging from .006-in. to .036-in., which is the range generally used with the direct cone drive without the back gears; when the upper lever is thrown to the left, the coarser feeds are obtained, ranging from .043-in. to .225-in., for use when the spindle is back geared. These speeds are proportioned inversely to the spindle speeds, thus obviating all feeding speeds that are detrimental to the machine.

The double back-gear arrangement for multiplying the driving speeds available from the cone involves a very interesting construction. This attachment is illustrated in Fig. 35, and is shown in detail in Fig. 36. Gears, E and F, revolve loosely upon the back-gear sleeve, V, when the back-gear is thrown in; for throwing either one of them in gear a double-throw taper key is provided, as shown at K, which will operate friction clutches to throw either gear into operation, but never both. In this way the back-gear furnishes two extra runs of speeds instead of one, as is the usual arrangement.

The friction clutches consist of the rings, N, within their respective gears, E and F, which are opened by the plugs, G. These plugs, which have tapering sides, are forced up by the double taper key, K. The friction rings are made to snap tight on the spool, J, so that when the plug, G, is withdrawn, the ring fits tightly on the spool, centering itself and relieving the gear of all friction. The wedge action of the key is carried by yoke, Y, which in turn is moved by the lever, M, shown at the side of the column.

The special advantage of applying the friction clutch at this point is that, on account of its high speed, its power is multiplied a good many times before it reaches the spindle, as the clutch drives the back-gear pinion, which in turn drives the face gear. This makes it several times as powerful as would be a clutch direct in the face gear. It also enables the friction clutch to be carried under light tension, as well as permitting a better proportioned cone and higher belt speeds and better belt contact.

A very interesting comparison has been made by the Le-Blond Company, showing the relative spindle power of a double back-geared milling machine as compared with that of the ordinary single back-gear machine, for similar conditions in both instances, which clearly shows the superiority of the former. For examples a double back-geared drive and a regular single back-gear drive were compared, as indicated in Fig. 37, both of which had been calculated to give the same range of spindle speeds, from 12½ to 262 revolutions per minute. The countershaft on the double-geared machine runs at 180

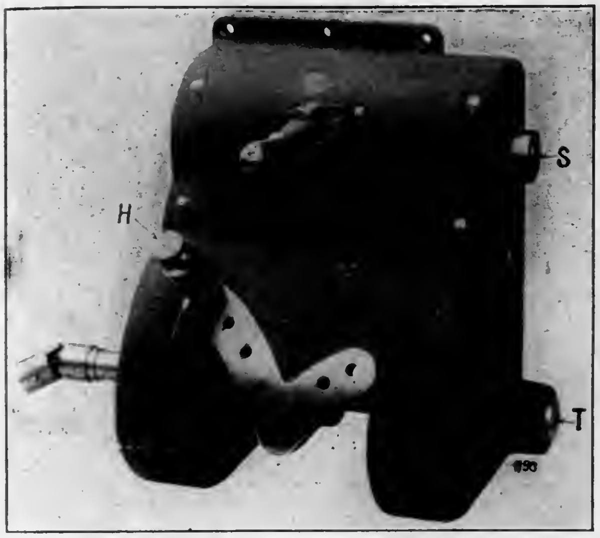


FIG. 32.—EXTERIOR VIEW OF 16-SPEED FEED GEAR BOX.

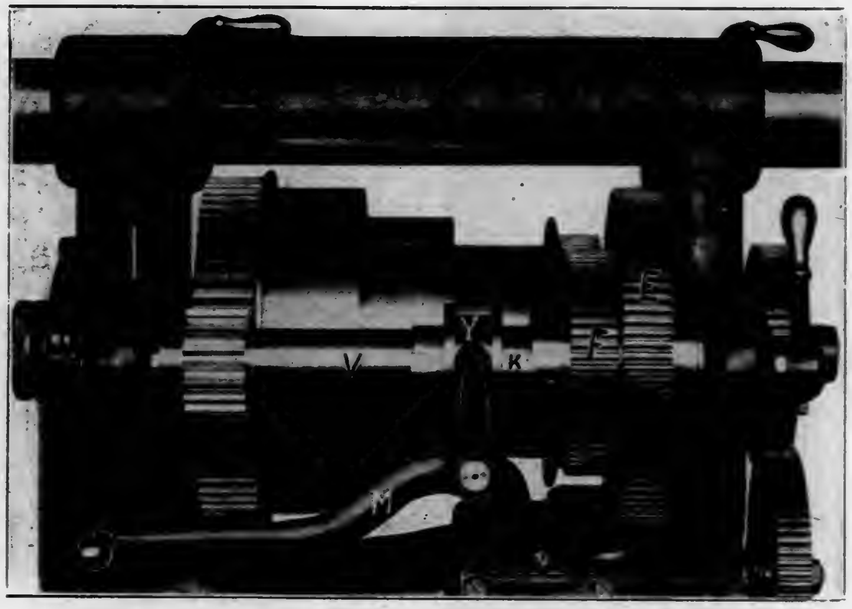


FIG. 35.—VIEW OF DOUBLE BACK-GEAR ATTACHMENT, SHOWING HANDLE FOR OPERATING THE FRICTION CLUTCHES.

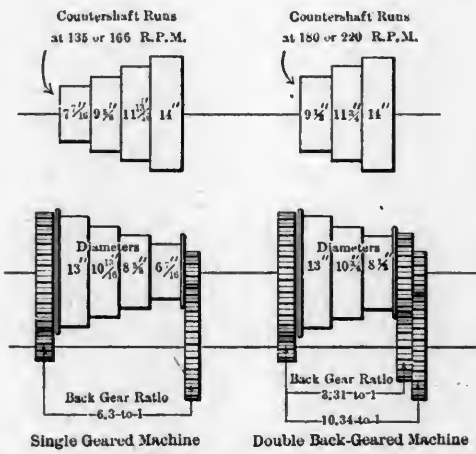


FIG. 37.—BACK-GEAR RATIOS FOR SINGLE AND DOUBLE BACK-GEARED MACHINES.

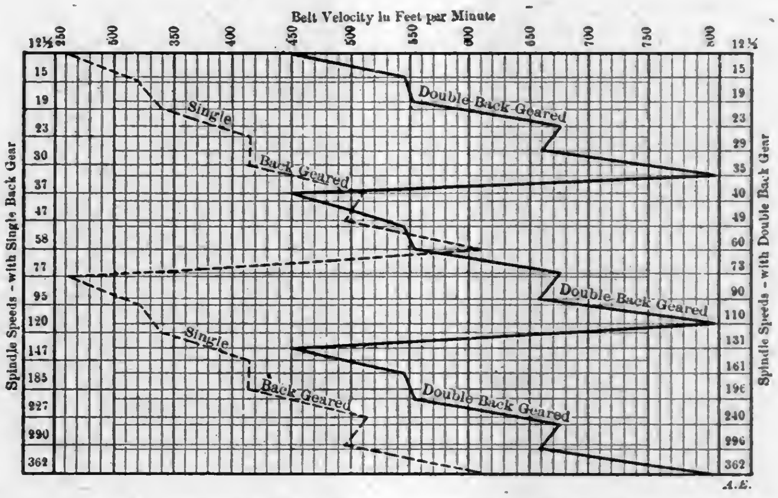


FIG. 38.—DIAGRAM SHOWING INCREASED BELT VELOCITY PROVIDED IN THE DOUBLE BACK-GEARED MACHINE.

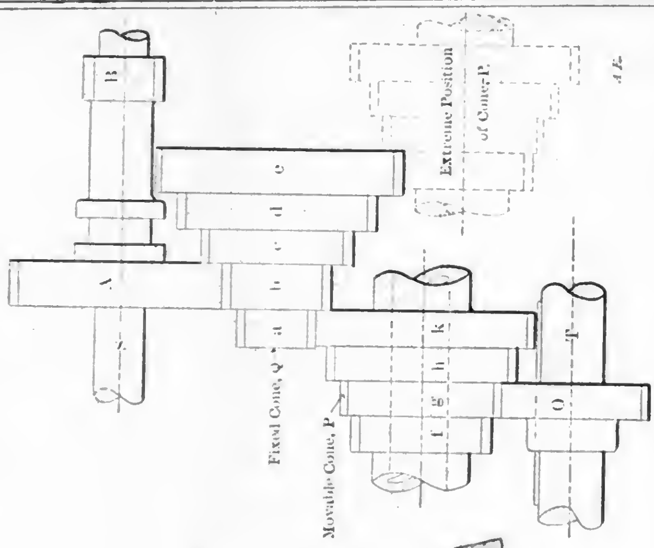


FIG. 34.—DIAGRAM ILLUSTRATING PRINCIPLE OF THE GEAR BOX DRIVE.

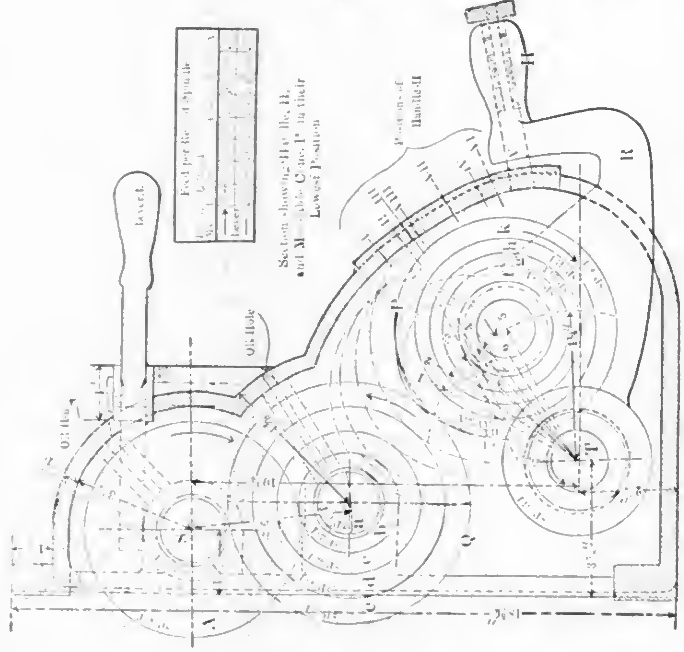


FIG. 33.—CROSS SECTION OF GEAR BOX, SHOWING ARRANGEMENT OF GEAR CONES.

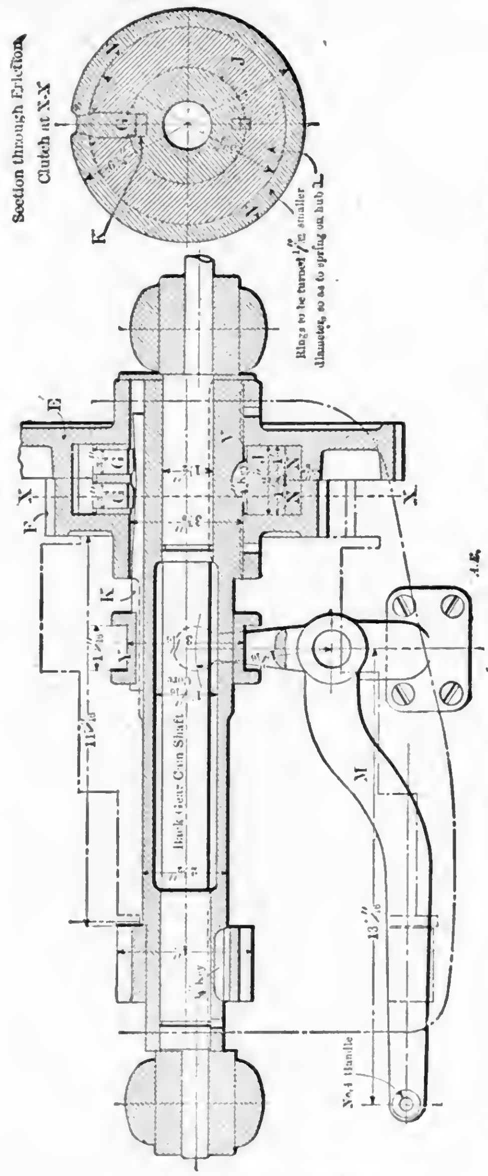


FIG. 36.—DETAILS OF THE FRICTION CLUTCHES FOR THE DOUBLE BACK-GEAR.

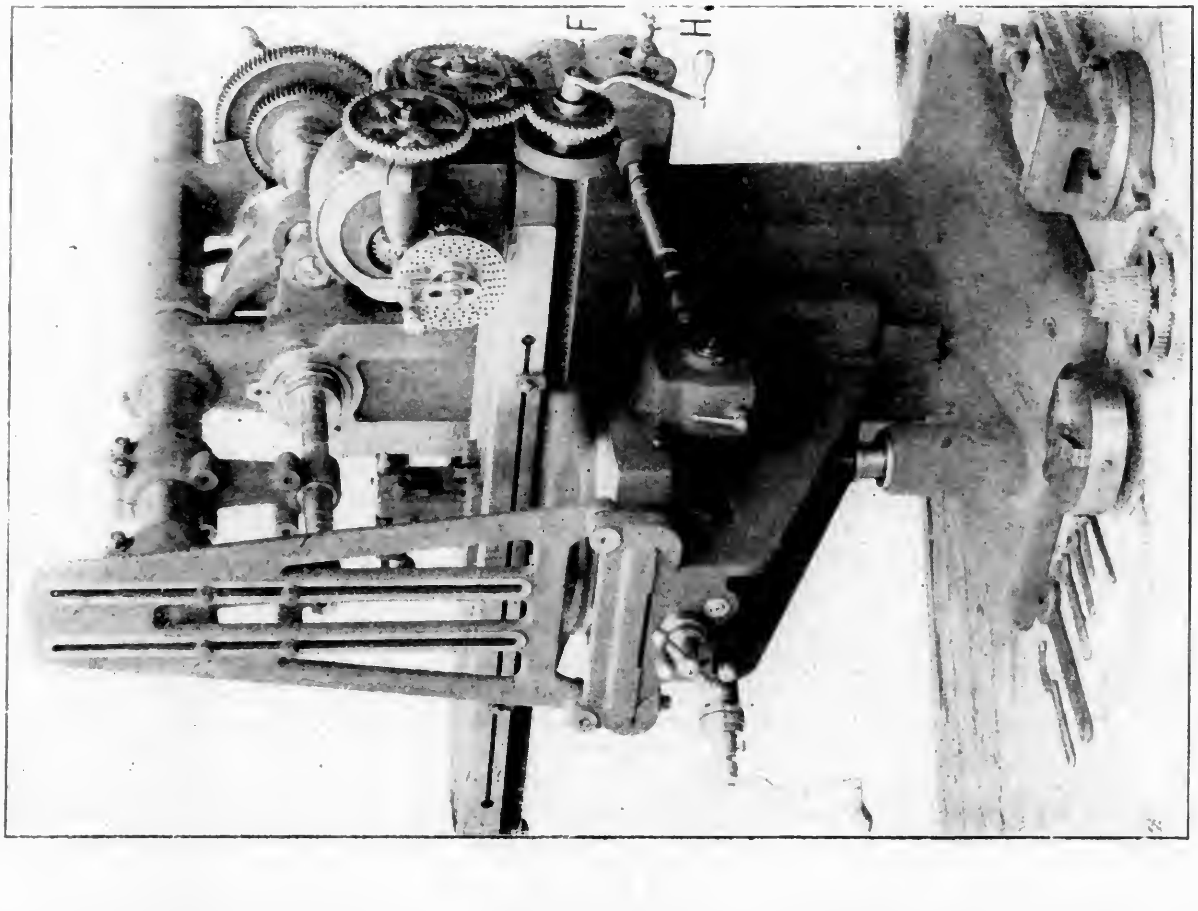


FIG. 31.—GENERAL VIEW OF THE NEW NO. 3 MILLING MACHINE.

NEW UNIVERSAL MILLING MACHINE.—THE R. K. LEBLOND MACHINE TOOL COMPANY.

tirely independent of the other—they may be operated separately or in unison.

The feeds are arranged in geometrical progression, ranging from .006-in. to .225-in. per revolution of the spindle. An engraved plate (reproduced in Fig. 33) is attached to the feed box which indicates the feeds obtained for each position of the handles. When the upper lever is thrown to the right, all the finer feeds are obtained, ranging from .006-in. to .036-in., which is the range generally used with the direct cone drive without the back gears; when the upper lever is thrown to the left, the coarser feeds are obtained, ranging from .043-in. to .225-in., for use when the spindle is back geared. These speeds are proportioned inversely to the spindle speeds, thus obviating all feeding speeds that are detrimental to the machine.

The double back-gear arrangement for multiplying the driving speeds available from the cone involves a very interesting construction. This attachment is illustrated in Fig. 35, and is shown in detail in Fig. 36. Gears, E and F, revolve loosely upon the back-gear sleeve, V, when the back-gear is thrown in; for throwing either one of them in gear a double-throw taper key is provided, as shown at K, which will operate friction clutches to throw either gear into operation, but never both. In this way the back-gear furnishes two extra runs of speeds instead of one, as is the usual arrangement.

The friction clutches consist of the rings, N, within their respective gears, E and F, which are opened by the plugs, G. These plugs, which have tapering sides, are forced up by the double taper key, K. The friction rings are made to snap tight on the spool, J, so that when the plug, G, is withdrawn, the ring fits tightly on the spool, centering itself and relieving the gear of all friction. The wedge action of the key is carried by yoke, Y, which in turn is moved by the lever, M, shown at the side of the column.

The special advantage of applying the friction clutch at this point is that, on account of its high speed, its power is multiplied a good many times before it reaches the spindle, as the clutch drives the back-gear pinion, which in turn drives the face gear. This makes it several times as powerful as would be a clutch direct in the face gear. It also enables the friction clutch to be carried under light tension, as well as permitting a better proportioned cone and higher belt speeds and better belt contact.

A very interesting comparison has been made by the Le Blond Company, showing the relative spindle power of a double back-geared milling machine as compared with that of the ordinary single back-gear machine, for similar conditions in both instances, which clearly shows the superiority of the former. For examples a double back-geared drive and a regular single back-gear drive were compared, as indicated in Fig. 37, both of which had been calculated to give the same range of spindle speeds, from 12½ to 262 revolutions per minute. The countershaft on the double-geared machine runs at 180

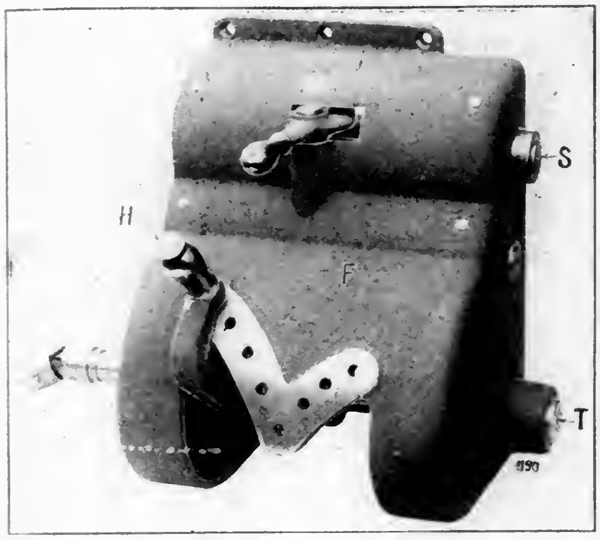


FIG. 32.—EXTERIOR VIEW OF 16-SPEED FEED GEAR BOX.

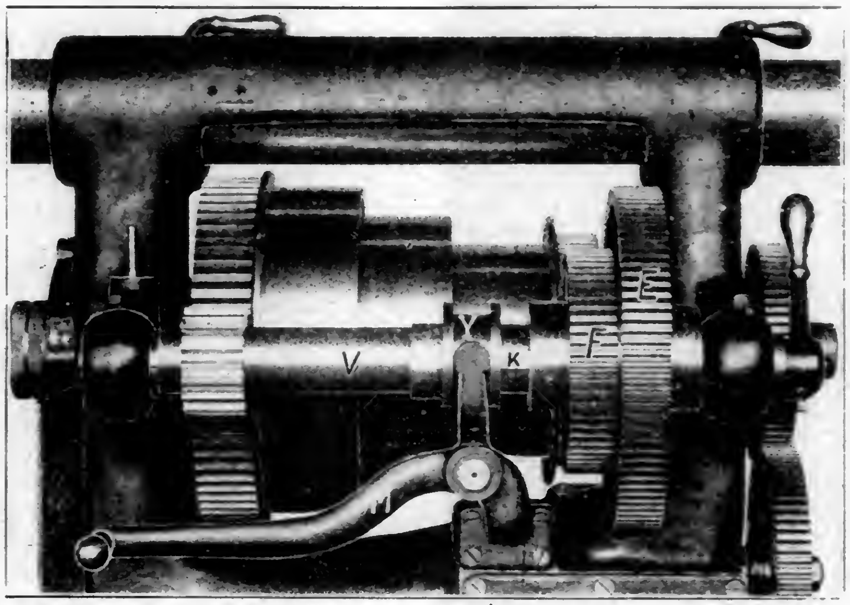


FIG. 35.—VIEW OF DOUBLE BACK-GEAR ATTACHMENT, SHOWING HANDLE FOR OPERATING THE FRICTION CLUTCHES.

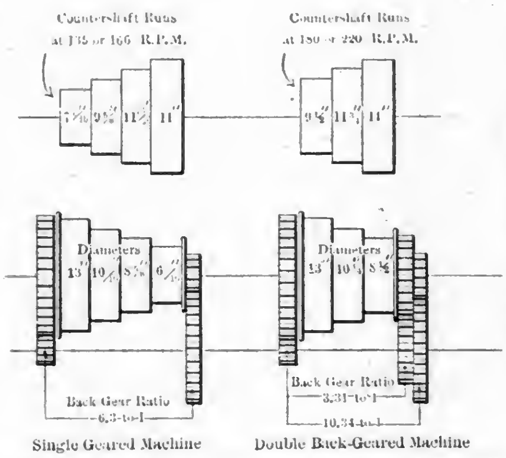


FIG. 37.—BACK-GEAR RATIOS FOR SINGLE AND DOUBLE BACK-GEARED MACHINES.

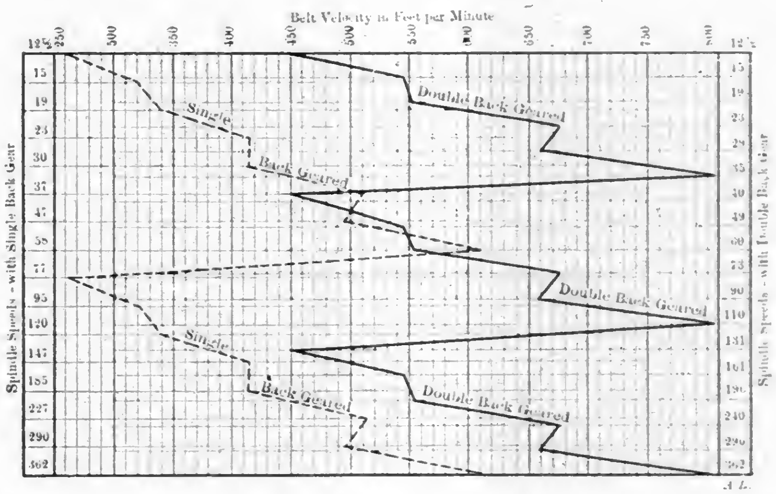


FIG. 38.—DIAGRAM SHOWING INCREASED BELT VELOCITY PROVIDED IN THE DOUBLE BACK-GEARED MACHINE.

and 220 revolutions per minute, while that on the single runs at 135 and 166 revolutions per minute, giving the double-geared machine a gain in power of 33 and 30 per cent., respectively, for the same size of belt. The cone diameters on the double-geared machine are 13, 10¾ and 8½ ins., while on the single-geared machine they are 13, 10¾ and 8⅝, and 6½ ins. in diameter; this gives an increased diameter on the smallest step of the cone of the double back-geared machine of 2½ ins., amounting to 32 per cent. increase of belt contact. This pertains as well to the small step of the countershaft cone, as the spindle and countershaft cones have their largest steps of the same size.

To illustrate this more fully a diagram is presented in Fig. 38, showing graphically the belt velocity in feet per minute on the two machines. The broken line represents the single-geared and the solid line the double back-geared machine. It will be seen that when the two machines are running at the slowest speed of 12½ revolutions per minute, the double back-geared machine has a cone belt velocity of 447 ft. per minute, while the single has a velocity of 267 ft. per minute, showing a gain for the double back-geared machine of 70 per cent. in power. This proportion of gain is maintained until a speed of 35 revolutions per minute is reached when, upon engaging the low ratio of the back gear, the belt speed of the double back-geared machine is reduced to about that of the single-geared machine; from this point on, however, the belt speed increases until at 75 revolutions per minute, there is a difference in belt travel of 390 ft. per minute, with a gain of 150 per cent in power.

There is still another feature to consider that has important bearing on the power of machines, namely: the ratio of back gear. Calculating the ratio of back-gear so as to give an even grade of speeds running in geometrical progression from 12½ to 362 revolutions per minute we get a back-gear ratio of 3.31 and 10.34 on the double back-geared machine, and 6.2 on the single back-geared machine, amounting to an increase of 74 per cent. in back-gear power for the double back-geared machine. This is better understood when it is considered that for a spindle speed of 12½ revolutions per minute, for example, the double back-gear would have a belt travel of 35 ft. per revolution, the single of 22, or a gain in belt travel of 13 ft. per revolution.

POWER TEST OF GROUP DRIVE MOTORS.

Records of Power Required for the Group Drives at the Roanoke Shops.

NORFOLK & WESTERN RAILWAY.

(Conclusion of the Tool List from Page 223.)

Diagrams presenting graphical records of the tests made upon these groups are to be found on page 223 of the preceding (June 1903) issue of this journal.

GROUP NO. 8.—25-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 30.7 H.P.
Minimum power required = 12.2 H.P.
Average power required = 18.4 H.P.

Univ. boring mill	37 ins.	Niles.
Univ. boring mill	37 ins.	Niles.
Shaper	12 ins.	Bement & Son.
Planer	36 x 36 ins.	Sellers.
Lathe	18 ins.	Niles.
Drill press	32-in. table	Prentice Bros. Co.
Milling machine		Brainard.
Drill press	18-in table	Prentice Bros. Co.
Planer	30 x 30 ins.	Sellers.
Emery wheel		
Shaper	12 ins.	Bement, Miles & Co.
Planer	36 x 36 ins.	Sellers.
Lathe		
Hor. boring machine	No. 2½	Niles.
Drill press		
Hor. boring machine		Niles.
Hor. boring machine		Bement & Son.
Slotter	18 ins.	Niles.
Nut facer		Newton.
Drill press		Bement & Son.
Testing machine	200,000 lbs. capacity	Riehle Bros.

GROUP NO. 9.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 34.1 H.P.
Minimum power required = 10.6 H.P.
Average power required = 15.4 H.P.

Driving-wheel lathe	80-in. plate	Sellers.
Truck-wheel lathe	24 ins.	Bement & Son.
Key seater		Miles & Merrill.
Lathe	18 ins.	Pond.
Driving-wheel lathe	84-in. plate	Niles.
Lathe, extension	14 ins.	Harrington & Son.
Lathe, extension	15 ins.	Sellers.
Driving-wheel lathe	60 ins.	Niles.
Planer	30 x 30 ins	Harrington & Son.
Lathe	18 ins.	Niles.
Vert. boring mill	51 ins.	Niles.
Planer	30 x 30 ins	Harrington & Son.
Walking crane		

BOILER AND ERECTING SHOP.

GROUP NO. 11.—25-H.P. C. & C. MOTOR.

Maximum power required = 20 H.P.
Minimum power required = 15.4 H.P.
Average power required = 18.2 H.P.

Emery wheel		
Lathe	7 ins.	Grant & Bogert.
Drill press	12-in. table	
Drill press	26-in. table	Prentice Bros.
Staybolt cutter		Blair.
Staybolt cutter		Blair.
Radial drill press		Kelly & Ludwig.
1 shear and punch		Long & Alstatter.
1 shear and punch		Long & Alstatter.
4-spindle drill		Bement & Son.
Plate planer		Dunkirk Iron Works.
Horizontal punch		Long & Alstatter.
Blower	No. 33	Sturtevant.
Rolls	No. 5	Niles.

SMITH SHOP AND FLUE ROOM.

GROUP NO. 13.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 12.3 H.P.
Minimum power required = 2.9 H.P.
Average power required = 9.1 H.P.

Small bolt header		
Small bolt header		
Small bolt header		
Large bolt header		
Large bolt header		
Large bolt header		

GROUP NO. 15.—50-H.P. EDDY MOTOR.

Maximum power required = 60.3 H.P.
Minimum power required = 39 H.P.
Average power required = 52.3 H.P.

Fan	No. 10	Sturtevant.
Flue welder		
Flue welder		
Flue cutter		

GROUP NO. 17.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 19 H.P.
Minimum power required = 4.4 H.P.
Average power required = 12.4 H.P.

Shears		
Shears		
Bolt cutter, D. H		Acme.
Bolt cutter, D. H		Acme.
Bolt cutter, D. H		Acme.
Bolt cutter, D. H		Acme.
Bolt cutter, D. H		Acme.
Bolt cutter, S. H		R. M. W.
Bolt cutter, D. H		Acme.
Bolt cutter, S. H		R. M. W.
Nut tapper		Howard Bros.

FOUNDRY.

GROUP NO. 18.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 13.8 H.P.
Minimum power required = 5.4 H.P.
Average power required = 10.4 H.P.

2 rattlers (small)		
Fan (small)		
Brass borer		
2 emery wheels		

GROUP NO. 19.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 16.2 H.P.
Minimum power required = 4.2 H.P.
Average power required = 11 H.P.

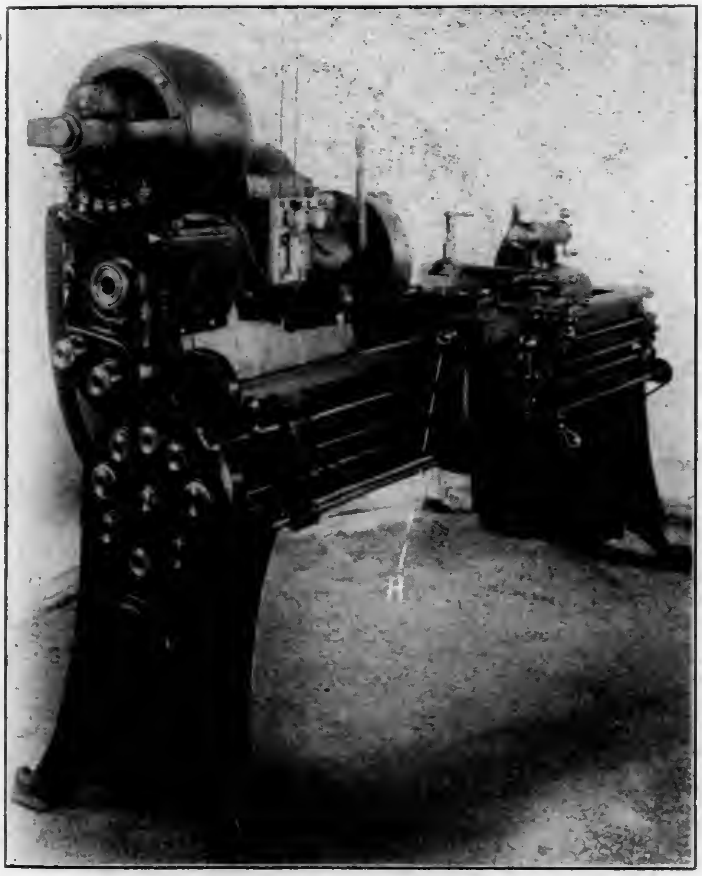
1 rattler	6 ft. 6 ins. long	
1 rattler	4 ft. long	
2 double emery wheels		

The Endura Company, Limited, 92 Griswold street, Detroit, Mich., have issued a circular describing Endura Coating and illustrating an overhead bridge of the New York Central at Mott Haven, New York, which was protected with it two and a half years ago. It includes a letter from Mr. Olaf Hoff, engineer of structures of the road, stating that the paint was in good condition after two years of service. This paint is specially intended for the protection of metallic surfaces. It supplies an elastic, flexible protection with a heavy body and excellent adhesive qualities, and is advocated as a preservative for steel cars. The pamphlet also contains letters from J. S. Culver, president of the Culver Construction Company, Springfield, Illinois; George I. King, manager steel car department of the American Car & Foundry Company, and W. E. Nichols, purchasing agent of the Pacific Coast Company.

A NEW DESIGN OF ELECTRIC DRIVE FOR THE IDEAL LATHE.

SPRINGFIELD MACHINE TOOL COMPANY.

A very interesting motor drive application has recently been designed by the Springfield Machine Tool Company, Springfield, Ohio, for use upon their well-known "Ideal" engine lathe. The method of mounting the motor upon the headstock, which is used, is an entirely new departure in motor driving. The headstock arrangement has been entirely redesigned to accommodate the gearing and connections for the drive, so that as a result the motor actually appears to form an integral part of the lathe's construction and does not give the impression of being an after consideration.



A NOVELTY IN ELECTRIC DRIVING FOR THE "IDEAL" LATHE.—SPRINGFIELD MACHINE TOOL COMPANY.

The accompanying view illustrates the new drive upon their 16-in. x 8-ft. Ideal lathe, two of which lathes have been furnished, thus equipped, to the Northern Electrical Manufacturing Company, Madison, Wis. This lathe was, as will be remembered, described on page 157 of our May, 1902, issue, and also with particular reference to its novel rapid feed-changing mechanism, on page 27 of our January, 1903, issue. The motor is mounted directly upon a pair of lugs cast integral with the headstock, from which position it drives direct to the spindle through gearing. The drive is through a reduction gearing to an intermediate slip-gear shaft, which may drive the spindle at either of two speeds. The slip gears are controlled by a handle on the gear case at the right of the motor, so that either run of gears may easily be thrown in. These two runs of gears are supplemented by the usual back gear attachment, making four different speeds available by gearing.

The motor, which is a 1½-h.p. variable-speed direct-current motor, made by the Northern Electrical Manufacturing Company, operates on the two-wire system, the speed control being obtained by field resistance control, which gives a variation at the armature shaft of from 600 to 1,200 revolutions per minute, or 2 to 1. The motor controlling rheostat is located inside of the legs beneath the right-hand end of the lathe's bed and is operated, through the agency of a splined shaft and sprocket chain, from the carriage. The handle, H, on the carriage operates through a sliding gear on the splined shaft so that the motor is under control, no matter what position the carriage is in.

This arrangement of driving is worthy of careful consideration for its extreme compactness, yet great flexibility, as it gives a total spindle speed range of from 6 to 310 r.p.m., by both electrical and mechanical speed changes. This is a firm step toward a rational design of motor driving, inasmuch as a very wide speed range is obtained, and with a large number of steps, yet with no irregularities of either lathe or motor design.

BOOKS AND PAMPHLETS.

Steam Power Plants; Their Design and Construction. By Henry C. Meyer, Jr., M. E.; 160 pages, 8 vo., cloth; 16 folding plates and 65 figures in the text. Published by the McGraw Publishing Company, 114 Liberty street, New York. Price, $2.00.

This is a work of exceptional value to all interested in power plant construction or design. It is an elaboration of a series of articles by the author which orginally appeared in the *Engineering Record*, and which were intended for engineers in charge of machine shops who are called on to design and purchase a steam-power plant or parts of it when their knowledge of the machinery that goes into such a plant is more or less limited, and when they are not able to obtain the advice of a competent consulting engineer. The book as a whole is well written and contains a great deal of valuable information in a small space. The power-plant engineer will find little in it that is entirely new, but he will find much that is worth his attention as a reminder of the many things that have to be considered in designing. To such engineers perhaps the most useful part of the book will be the sixteen folding plates, most of which are ground plans and sectional elevations of recent plants, showing the location of boilers, engines, piping, etc. This volume contains much valuable data in accessible and convenient form.

Modern Machine Shop Tools. Their Construction, Operation and Manipulation. By Wm. H. Van Dervoort, M. E.; 552 pages, profusely illustrated with 673 engravings; 8 vo., cloth. Published by Norman W. Henley & Co., 132 Nassau street, New York. Price, $4.00.

This is a practical treatise on general machine shop practice, and is especially important on account of being brought right up to date in all details. The subjects are treated in a clear and comprehensive manner and are intended to serve as a text-book for the apprentice and also as a convenient reference volume for the machinist and shop foreman. The work begins with a treatise of the hammer and cold chisel, filing, scraping, etc., and of all the ordinary hand tools, after which gauges, indicators, etc., are considered, followed by several chapters on drills, reamers, taps, dies, mandrels, etc. The remaining portion of the volume treats of the various machine tools, and various processes of grinding and hardening and tempering. Special mention should be made of the excellent treatment of the subject of grinding. This work is of great value to all interested in machine shop practice and we heartily commend it for their use.

A. Leschen & Sons Rope Company, 920 North First street, St. Louis, have issued a new catalogue No. 24, describing the wire rope and cordage of every description manufactured by them. Their flattened strand wire ropes are specially noteworthy because of being free from tendencies to spin or kink, and because of their large wearing surfaces. Those requiring wire rope and fittings, blocks and accessories or rope tramway equipment will find all necessary information in this catalogue, which may be had upon application at the offices of the company.

A list of users of the Reynolds-Corliss engines has been issued by the Allis-Chalmers Company, containing a partial statement of the locations of engines of this type built by that company at their Milwaukee works. Eighteen pages are occupied by the index of States and cities in which the engines are located. The list covers 190 pages and gives the size of each engine. It is a magnificent record and exhibit of the esteem in which the product of these works is held.

and 220 revolutions per minute, while that on the single runs at 135 and 166 revolutions per minute, giving the double-geared machine a gain in power of 33 and 30 per cent., respectively, for the same size of belt. The cone diameters on the double-geared machine are 13, $10\frac{3}{4}$ and $8\frac{1}{2}$ ins., while on the single-geared machine they are 13, $10\frac{3}{4}$ and $8\frac{5}{8}$, and $6\frac{1}{2}$ ins. in diameter; this gives an increased diameter on the smallest step of the cone of the double back-geared machine of $2\frac{1}{2}$ ins., amounting to 32 per cent. increase of belt contact. This pertains as well to the small step of the countershaft cone, as the spindle and countershaft cones have their largest steps of the same size.

To illustrate this more fully a diagram is presented in Fig. 38, showing graphically the belt velocity in feet per minute on the two machines. The broken line represents the single-geared and the solid line the double back-geared machine. It will be seen that when the two machines are running at the slowest speed of $12\frac{1}{2}$ revolutions per minute, the double back-geared machine has a cone belt velocity of 447 ft. per minute, while the single has a velocity of 267 ft. per minute, showing a gain for the double back-geared machine of 70 per cent. in power. This proportion of gain is maintained until a speed of 35 revolutions per minute is reached when, upon engaging the low ratio of the back gear, the belt speed of the double back-geared machine is reduced to about that of the single-geared machine; from this point on, however, the belt speed increases until at 75 revolutions per minute, there is a difference in belt travel of 390 ft. per minute, with a gain of 150 per cent in power.

There is still another feature to consider that has important bearing on the power of machines, namely: the ratio of back gear. Calculating the ratio of back-gear so as to give an even grade of speeds running in geometrical progression from $12\frac{1}{2}$ to 362 revolutions per minute we get a back-gear ratio of 3.31 and 10.34 on the double back-geared machine, and 6.2 on the single back-geared machine, amounting to an increase of 74 per cent. in back-gear power for the double back-geared machine. This is better understood when it is considered that for a spindle speed of $12\frac{1}{2}$ revolutions per minute, for example, the double back-gear would have a belt travel of 35 ft. per revolution, the single of 22, or a gain in belt travel of 13 ft. per revolution.

POWER TEST OF GROUP DRIVE MOTORS.

Records of Power Required for the Group Drives at the Roanoke Shops.

NORFOLK & WESTERN RAILWAY.

(Conclusion of the Tool List from Page 223.)

Diagrams presenting graphical records of the tests made upon these groups are to be found on page 223 of the preceding (June 1903) issue of this journal.

GROUP NO. 8.—25-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 30.7 H.P.
Minimum power required = 12.2 H.P.
Average power required = 18.1 H.P.

Cyl. boring mill	37 ins.	Niles.
Cyl. boring mill	7 ins.	Niles.
Shaper	12 ins.	Bement & Son.
Planer	26 x 26 ins.	Sellers.
Lathe	18 ins.	Niles.
[illegible]	2[illegible]-in. table	Prentice Bros. Co.
[illegible]		Brainard.
Drill press	18-in. table	Prentice Bros. Co.
Planer	30 x 30 ins.	Sellers.
[illegible]		
[illegible]	42 ins.	Bement, Miles & Co.
[illegible]	[illegible]	Sellers.
Lathe		
Hor. boring machine	No. 2	Niles.
Drill press		
Hor. boring machine		Niles.
Hor. [illegible]		Bement & Son.
[illegible]	18 ins.	Niles.
Nut [illegible]		Newton.
Drill press		Bement & Son.
[illegible]	200,000 lbs. capacity	Riehle Bros.

GROUP NO. 9.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 31.1 H.P.
Minimum power required = 10.6 H.P.
Average power required = 15.4 H.P.

Driving-wheel lathe	80-in. plate	Sellers.
Truck-wheel lathe	[illegible]1 ins.	Bement & Son.
Key seater		Miles & Merrill.
Lathe	18 ins.	Pond.
Driving-wheel lathe	84-in. plate	Niles.
Lathe, extension	14 ins.	Harrington & Son.
Lathe, extension	15 ins.	Sellers.
Driving-wheel lathe	60 ins.	Niles.
Planer	30 x 30 ins.	Harrington & Son.
Lathe	18 ins.	Niles.
Vert. boring mill	51 ins.	Niles.
Planer	30 x 30 ins.	Harrington & Son.
Walsing crane		

BOILER AND ERECTING SHOP.

GROUP NO. 11.—25-H.P. C. & C. MOTOR.

Maximum power required = 20 H.P.
Minimum power required = 15.4 H.P.
Average power required = 18.2 H.P.

Emery wheel		
Lathe	7 ins.	Grant & Bogert.
Drill press	12-in. table	
Drill press	26-in. table	Prentice Bros.
Staybolt cutter		Blair.
Staybolt cutter		Blair.
Radial drill press		Kelly & Ludwig.
1 shear and punch		Long & Alstatter.
1 shear and punch		Long & Alstatter.
4-spindle drill		Bement & Son.
Plate planer		Dunkirk Iron Works.
Horizontal punch		Long & Alstatter.
Blower	No. 33	Sturtevant.
Rolls	No. 5	Niles.

SMITH SHOP AND FLUE ROOM.

GROUP NO. 13.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 12.3 H.P.
Minimum power required = 2.9 H.P.
Average power required = 9.1 H.P.

Small bolt header		
Small bolt header		
Small bolt header		
Large bolt header		
Large bolt header		
Large bolt header		

GROUP NO. 15.—50-H.P. EDDY MOTOR.

Maximum power required = 60.3 H.P.
Minimum power required = 39 H.P.
Average power required = 52.3 H.P.

Fan	No. 10	Sturtevant.
Flue welder		
Flue welder		
Flue cutter		

GROUP NO. 17.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 19 H.P.
Minimum power required = 4.1 H.P.
Average power required = 12.4 H.P.

Shears	
Shears	
Bolt cutter, D. H.	Acme.
Bolt cutter, D. H.	Acme.
Bolt cutter, D. H.	Acme.
Bolt cutter, D. H.	Acme.
Bolt cutter, D. H.	Acme.
Bolt cutter, S. H.	R. M. W.
Bolt cutter, D. H.	Acme.
Bolt cutter, S. H.	R. M. W.
Nut tapper	Howard Bros.

FOUNDRY.

GROUP NO. 18.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 13.8 H.P.
Minimum power required = 5.4 H.P.
Average power required = 10.4 H.P.

2 rattlers (small)	
Fan (small)	
Brass borer	
2 emery wheels	

GROUP NO. 19.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 16.2 H.P.
Minimum power required = 4.2 H.P.
Average power required = 11 H.P.

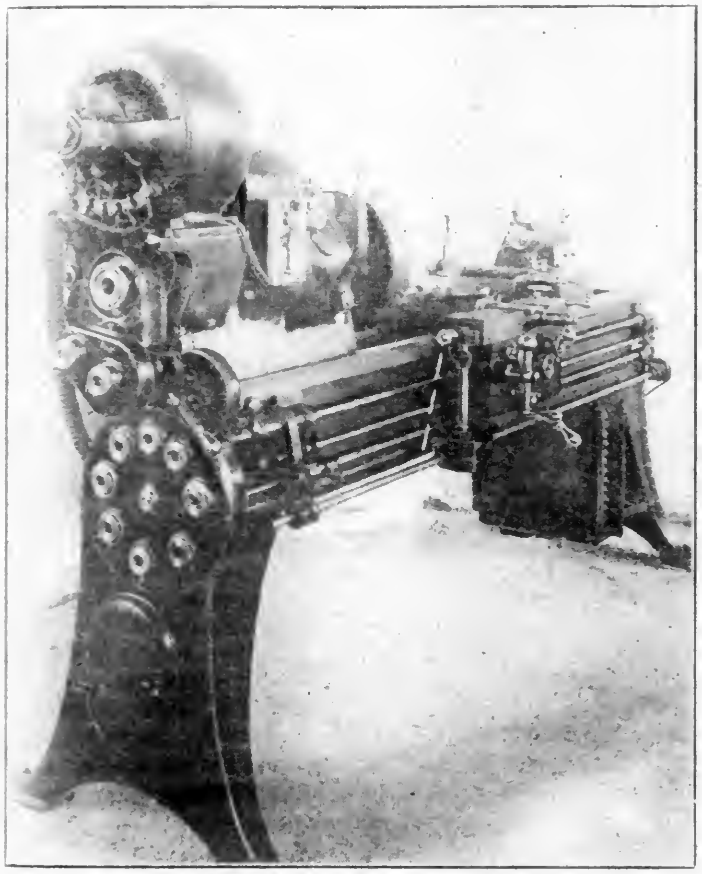
1 rattler	6 ft. 6 ins. long
1 rattler	4 ft. long
2 double emery wheels	

The Endura Company, Limited, 92 Griswold street, Detroit, Mich., have issued a circular describing Endura Coating and illustrating an overhead bridge of the New York Central at Mott Haven, New York, which was protected with it two and a half years ago. It includes a letter from Mr. Olaf Hoff, engineer of structures of the road, stating that the paint was in good condition after two years of service. This paint is specially intended for the protection of metallic surfaces. It supplies an elastic, flexible protection with a heavy body and excellent adhesive qualities, and is advocated as a preservative for steel cars. The pamphlet also contains letters from J. S. Culver, president of the Culver Construction Company, Springfield, Illinois; George I. King, manager steel car department of the American Car & Foundry Company, and W. E. Nichols, purchasing agent of the Pacific Coast Company.

A NEW DESIGN OF ELECTRIC DRIVE FOR THE IDEAL LATHE.

Springfield Machine Tool Company.

A very interesting motor drive application has recently been designed by the Springfield Machine Tool Company, Springfield, Ohio, for use upon their well-known "Ideal" engine lathe. The method of mounting the motor upon the headstock, which is used, is an entirely new departure in motor driving. The headstock arrangement has been entirely redesigned to accommodate the gearing and connections for the drive, so that as a result the motor actually appears to form an integral part of the lathe's construction and does not give the impression of being an after consideration.



A NOVELTY IN ELECTRIC DRIVING FOR THE "IDEAL" LATHE.—SPRINGFIELD MACHINE TOOL COMPANY.

The accompanying view illustrates the new drive upon their 16-in. x 8-ft. Ideal lathe, two of which lathes have been furnished, thus equipped, to the Northern Electrical Manufacturing Company, Madison, Wis. This lathe was, as will be remembered, described on page 157 of our May, 1902, issue, and also with particular reference to its novel rapid feed-changing mechanism, on page 27 of our January, 1903, issue. The motor is mounted directly upon a pair of lugs cast integral with the headstock, from which position it drives direct to the spindle through gearing. The drive is through a reduction gearing to an intermediate slip-gear shaft, which may drive the spindle at either of two speeds. The slip gears are controlled by a handle on the gear case at the right of the motor, so that either run of gears may easily be thrown in. These two runs of gears are supplemented by the usual back gear attachment, making four different speeds available by gearing.

The motor, which is a 1½-h.p. variable-speed direct-current motor, made by the Northern Electrical Manufacturing Company, operates on the two-wire system, the speed control being obtained by field resistance control, which gives a variation at the armature shaft of from 600 to 1,200 revolutions per minute, or 2 to 1. The motor controlling rheostat is located inside of the legs beneath the right-hand end of the lathe's bed and is operated, through the agency of a splined shaft and sprocket chain, from the carriage. The handle, H, on the carriage operates through a sliding gear on the splined shaft so that the motor is under control no matter what position the carriage is in.

This arrangement of driving is worthy of careful consideration for its extreme compactness yet great flexibility, as it gives a total spindle speed range of from 6 to 310 r.p.m., by both electrical and mechanical speed changes. This is a firm step toward a rational design of motor driving inasmuch as a very wide speed range is obtained, and with a large number of steps, yet with no irregularities of either lathe or motor design.

BOOKS AND PAMPHLETS.

Steam Power Plants; Their Design and Construction. By Henry C. Meyer, Jr., M. E.; 160 pages, 8vo., cloth; 16 folding plates and 65 figures in the text. Published by the McGraw Publishing Company, 114 Liberty street, New York. Price, $2.00.

This is a work of exceptional value to all interested in power plant construction or design. It is an elaboration of a series of articles by the author which originally appeared in the *Engineering Record*, and which were intended for engineers in charge of machine shops who are called on to design and purchase a steam-power plant, or parts of it when their knowledge of the machinery that goes into such a plant is more or less limited, and when they are not able to obtain the advice of a competent consulting engineer. The book as a whole is well written and contains a great deal of valuable information in a small space. The power-plant engineer will find little in it that is entirely new, but he will find much that is worth his attention as a reminder of the many things that have to be considered in designing. To such engineers perhaps the most useful part of the book will be the sixteen folding plates, most of which are ground plans and sectional elevations of recent plants, showing the location of boilers, engines, piping, etc. This volume contains much valuable data in accessible and convenient form.

Modern Machine Shop Tools. Their Construction, Operation and Manipulation. By Wm. H. Van Dervoort, M. E. 552 pages, profusely illustrated with 673 engravings; 8vo., cloth. Published by Norman W. Henley & Co., 132 Nassau street, New York. Price, $4.00.

This is a practical treatise on general machine shop practice, and is especially important on account of being brought fully up to date in all details. The subjects are treated in a clear and comprehensive manner and are intended to serve as a text book for the apprentice and also as a convenient reference volume for the machinist and shop foreman. The work begins with a treatise of the hammer and cold chisel, filing, scraping, etc., and of all the ordinary hand tools, after which gauges, indicators, etc., are considered, followed by several chapters on drills, reamers, taps, dies, mandrels, etc. The remaining portion of the volume treats of the various machine tools, and various processes of grinding and hardening and tempering. Special mention should be made of the excellent treatment of the subject of grinding. This work is of great value to all interested in machine shop practice, and we heartily commend it for their use.

A. Leschen & Sons Rope Company, 920 North First street, St. Louis, have issued a new catalogue No. 21, describing the wire rope and cordage of every description manufactured by them. Their flattened strand wire ropes are specially noteworthy because of being free from tendencies to spin or kink, and because of their large wearing surfaces. Those requiring wire rope and fittings, blocks and accessories or rope tramway equipment will find all necessary information in this catalogue, which may be had upon application at the offices of the company.

A list of users of the Reynolds-Corliss engines has been issued by the Allis-Chalmers Company, containing a partial statement of the locations of engines of this type built by that company at their Milwaukee works. Eighteen pages are occupied by the index of States and cities in which the engines are located. The list covers 190 pages and gives the size of each engine. It is a magnificent record and exhibit of the esteem in which the product of these works is held.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

THE CONVENTIONS.

It will be necessary to reserve our comments upon the three important conventions which have just closed at Saratoga until next month on account of the unusually late date at which they were held this year. We have, however, been enabled to present abstracts of several of the papers and also the discussions at the Master Mechanics' and Master Car Builders' conventions.

LOCOMOTIVE TESTING PLANT AT THE ST. LOUIS EXPOSITION.

A locomotive testing laboratory is to be operated in the transportation department of the approaching exposition at St. Louis. Mr. Willard A. Smith, chief of that department, announces that the Pennsylvania Railroad will construct a plant for permanent installation at Altoona, and that this will be temporarily erected at the exposition as a part of the exhibit of that road. The entire exhibit will be under the charge of Mr. F. D. Casanave, formerly general superintendent of motive power of that road. Nothing of this kind has ever been attempted in connection with an exposition, and the valuable results already obtained upon locomotive testing plants in this country may be considered a promise of most important accomplishments at St. Louis. If a completely equipped testing plant is kept busy for seven months at the exposition and the work is carefully planned and executed, as it is sure to be, the undertaking will undoubtedly be a step toward a thorough scientific study of the modern locomotive, than which there can be no more fruitful investigation in connection with the subject of transportation.

A NEW LIGHT ON ELECTRIC LOCOMOTIVES.

If a locomotive could be always counted upon to go out upon its run, and after a run be ready to turn about immediately for the next one, it would be worth 2, or perhaps 4, or even 10 cents per mile more than one which will not do this. The electric locomotive has in this respect a stronger claim to-day for the attention of railroad men than those of economy or efficiency. The time seems to be approaching when the units of power will become so large that they must be concentrated into stationary power stations. In a transcontinental trip one now finds several opportunities for electric helper service which would now be profitable and will soon be necessary.

PILES OF WORK.

"Pile work up in front of a man and move the finished pieces promptly on to the next one when finished. Show men that the work is wanted. Get the material moving, and soon the whole shop will take a lively gait," says the progressive superintendent of a big railroad shop. What inducement does a lathe hand have for pushing his machine if the floor behind him is littered with the finished work of two or three days? Keep the floor clean of finished work, and pile up the raw material. This means a clean shop, and a clean shop means an effective and economical one. It means that the foreman will soon be wanted for larger shops, or at least for larger positions. Many shops which are now too small would be very much larger if this simple plan is carried out. It is a fact that a newspaper man always finds more to write about in a tidy shop than in a dirty, cluttered one, and it is easy to discover foremen who are fit to be master mechanics, and shop men who are capable of becoming foremen.

IMPROVED TOOLS REQUIRE IMPROVED WORKMEN.

In facing driving boxes on the Newton horizontal milling machine at the Collinwood shops of the Lake Shore is an interesting example illustrating the need for superior workmen to handle modern machine tools. This machine takes 12 driving boxes on its bed, the castings being hooked together, making a horizontal cut of about 24 ins. in width. With a 3-16-in. cut and ordinary tool-steel cutters the table speed is 7 ins. per minute on cast-iron boxes. This requires about 3 minutes per box, or, as they are arranged on the table, 20 minutes for the lot. It then requires an hour for a good man to set up the machine for another lot. If done on a planer, the job would require about four hours. This machine now has a 15-h.p. motor, and the circuit-breaker is "knocked out" under this work. A 20-h.p. motor will be applied. The motor, however, has nothing to do with the large proportion of time required to set the work in the machine. This operation is now a question of the machine being ahead of the man.

The omission of pits in locomotive erecting shops is now seriously considered in several new shop plans involving the longitudinal arrangement of tracks. This is due to a desire to avoid cutting up the floor with deep pits running the full length of the shop. With one long pit the full length of the shop in the center, the outer pits may be shortened to a short distance from one end, but it does not seem advisable to attempt to do without pits altogether. Deep pits are not necessary. Probably 18 or 24 ins. will be sufficient, but if the engines are placed on the floor it will be necessary to raise them on blocking for the men to work under them. This involves raising the men also on staging or blocking for a large amount of their work. The inconvenience and expense of this will be at once apparent.

Considering the fact that the probable life of a locomotive is about twenty years, it is most important that the policy of the designer should be a far-sighted one. Many roads find it a serious handicap to operate light, inadequate locomotives built, perhaps, seven or eight years ago, mixed up with

heavier types of more recent date. There is a tendency to give the weak engines more work than they can properly do. The mechanical engineer of a Western road comments upon this in connection with tonnage rating tests upon which he has recently been engaged and says: "We find that our 19 x 24-in. 10-wheel engines with 1,700 sq. ft. of heating surface and 30 sq. ft. of grate area are very limited in their capacity to get freight up a long, heavy grade. They are not lacking in cylinder power, but in the ability to make steam. The incapacity of the boiler is further indicated by the fact that the gases escape from the smokebox at a temperature of 1,200 deg. F. and over, while our recent heavy engines discharge their smokebox gases at only about 600 deg." This illustrates very clearly the importance of present tendencies toward most careful study of boiler capacity in deciding upon new designs. This correspondent speaks of conditions which are found on every railroad.

One of the large life insurance companies of New York recently inaugurated a school of insurance, to aid in recruiting the staff of subordinate officers and agents. One requirement of applicants was that that they should be young men who had worked their way through college. Whatever the object of this, the result would naturally be to secure applicants who, from experience, knew and understood the meaning of difficulties. Most college men have an easy time. Those who work their way certainly do not, and they generally succeed afterward. The reason why they succeed is perfectly plain. They have the advantage of personal responsibility which such a course brings to them and they get it early in life.

A technical school graduate is usually past the age of 24 years when he begins his actual work. If he then serves three years as an apprentice he is at a disadvantage because of his age. The age of 27 is rather late to begin. Would it not be better for all technical men to begin in the shop in such a way as to throw responsibility upon them at the very start instead of giving them the apprenticeship? Granting that an apprentice course would give a better general idea of the department as a whole than could be obtained in the same length of time in the shop as an independent workman, yet there is something in the experience of the workman in the form of responsibility that the special apprentice does not usually acquire and cannot easily obtain at the age of 27 years. As a general principle would it not be better for all concerned, and particularly for the young graduate, to turn him loose in the shop to make his own way? In other words, is not the three or four years of special apprenticeship a handicap?

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

Machine-tool builders, of course, always make their machines strong enough to carry the heaviest possible cuts without any breakage or chattering; but a 96-in. boring mill of a familiar make did break down a few days before the visit of our representative to a certain large new shop. A 10-h.p. motor drove it, and with a 3-16-in. cut and ⅛-in. feed, boring a Latrobe tire, six teeth were broken out of the gears. The cutting speed was 28 ft. per minute. This cut was being made with a tool which had previously bored through five 56-in. tires at 28 ft. per minute, without being sharpened. That is pretty good tool steel.

This machine is, by the way, a good subject for a three-page editorial. Its motor control gives six motor speeds, and being an up-to-date machine, the gears and back gears give eight more changes, or 48 speeds in all. This is commendable, if the machine needs them, but here is something bordering on the absurd. By using a "feet per minute" indicator it was discovered that the total range of speed of the edge of that 96-in. table was from 16 to 975 ft. per minute. At the highest of these speeds chips which had dropped into the slots were thrown 25 ft. from the machine. It is unsafe to run these machines at such speeds. No work could ever require them, and the builders and those who work up motor drives should look into these things, and not allow inquisitive newspaper men to discover them. We shall probably receive a few dozen letters because of this paragraph, but let the reader decide whether 10 miles an hour is not pretty fast for a boring-mill table to travel. This machine is *fast* enough for one intended to pull heavy cuts, but it is not *strong* enough. It is "up to" the builders.

This interesting machine is in the hands of an intelligent man who takes pride in the fact that he "sets" a 54-in. tire, bores it, and gets it out of the machine in 31 minutes. With Latrobe tires he takes a cut of ⅛ in. and ¼-in. feed at 31 ft. per minute, but finds only one brand of tool steel which will do this work.

On some of the Western roads where travel is heavy it has been found necessary to equip passenger cars with tandem draft gear because of the excessive opening of the gear by the heavy pulls required in starting. In the case of a 16-car train the ordinary single gear is not sufficient to provide for the draw-bar stresses.

This suggests again the advisability of lightening passenger equipment. It seems rather strange that with an average the year around of 10 passengers per sleeper, or less, a weight of 125,000 or 130,000 lbs. in the cars should not lead to a protest from operating officials because of the expense which these heavy cars entail. At present it seems almost hopeless to suggest steel frames and lighter construction and steel trucks for passenger equipment, but the present tendency toward greater weights cannot continue indefinitely. It is believed that fame and fortune await the man who can produce satisfactory and smooth-riding cars with a reasonable amount of weight per passenger. These remarks are prompted by expressions of helplessness from several motive power officers because of the increase of "engine failures" and the zest with which the locomotive departments are pursued by the operating men. Locomotives, of course, should not fail; but a little study of the increased demands on passenger locomotives during the past five years will show that they have received too little consideration in the progress toward the complete comfort and convenience of the traveling public. The comfort should not be less, but intelligent and experienced officers should attack the problem of how to supply it without making it impossible to operate train service regularly and satisfactorily.

The track tank has been used for many years in connection with passenger locomotives. It is now beginning to be appreciated as a factor in freight service. This is particularly noticeable on the Michigan Central in connection with fast freight trains, such as cattle, dressed meat and special horse trains. Time freights and other classes of freight trains running among passenger trains complicate the dispatching, especially if frequent stops are made. By utilizing the track tanks the fast freights on the Michigan Central are now run without a stop from Niles to Jackson, a distance of 103 miles, and the practice has been found very satisfactory. The freight engines on this section are two-cylinder Schenectady compounds, and the service referred to has been operating smoothly for over a year. The speeds are remarkably high for freight trains, but there seems to have been no trouble whatever from hot boxes. The driving and truck boxes are given special attention at the roundhouses. They are very carefully watched and frequently replenished with oil. The enginemen co-operate with the roundhouse force in reporting the necessity for attention. The special horse trains usually weigh about 700 to 750 tons, and they cover the 103 miles in about three hours. The other fast freights weigh from 1,000 to 1,500 tons, and make the run in four to five hours. Such runs cannot always be made without stopping, but whenever an intermediate stop is necessary, the engine and train crews are required to explain it, and every effort is made to avoid the necessity of an explanation. This method greatly facilitates business, and it draws attention to the track tank as an important element in successful operation. These are days when every possible contribution to the acceleration of traffic movement is eagerly sought.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

SEMI-ANNUAL MEETING, SARATOGA, JUNE 23 TO 26.

The time of holding the semi-annual meeting this year precludes the presentation of an account of the discussions in this issue. They will be referred to next month. Brief statements concerning those of the papers most likely to interest our readers are presented below:

"The Steam Turbine from an Operating Standpoint." By F. A. Waldron.—This paper contains a description and record of tests of the first Westinghouse-Parsons turbine to be put into practical operation outside of the works of the builders. It is a most gratifying record of satisfactory experience. This is believed to be the most important paper of the meeting because of the prominent place now taken by the steam turbine and the value of the opinions expressed. Extracts from the paper will appear in these columns. The author brought out the noteworthy fact that with an evaporation of 8.7 lbs. of water per pound of coal a brake horse-power can be delivered to the pulley of a motor for the consumption of 2.5 lbs. of coal. This allows 5 per cent. for banking. With average non-condensing engines three times this amount of coal would be necessary if the engines were distributed about the plant. Special attention is directed to the interesting table of motor tests accompanying this paper.

"Alternating Current Motors for Variable Speed." By W. I. Slichter.—Variable speeds may be obtained with alternating current motors. The author reviews the existing information on this subject and discusses the various methods of obtaining speed control. This paper ought to lead those having alternating current installations to consider the advisability of securing variable speeds for machinery which requires it, and its effect is to add an argument in favor of alternating installations, or, to express it in another way, this discussion shows that the lines between alternating and direct current propositions cannot be as sharply drawn as heretofore. This paper will be presented in our columns.

"Train Resistance, a Rational Formula." By J. B. Blood.—The author expresses the need of a formula which will permit of fitting motive power to its work "with a nicety." He recommends the following formula:

$$R = A + BM \times \left(C + \frac{D}{T} \right) M^n$$

Where R = resistance in lbs. per ton, M = speed in miles per hour, T = weight of train in tons, n = exponent = 1.8, A = coefficient of sliding friction, B = coefficient of rolling friction, C = coefficient of side resistance, D = coefficient of head and stern resistances.

The values of these coefficients are given in the paper as follows: A = 3 for heavy freight trains, 4 for average passenger trains, 5 for heavy large electric cars, 6 for medium electric cars, 7 for light electric cars; B = 0.15 for light track construction, 0.12 for heavy track construction; C = 0.0016 for ordinarily constructed cars, and 0.0014 for cars with vestibules; D = 0.25 for cars with small cross section, 0.30 for electric cars with medium cross section, 0.35 for large suburban cars, and 0.40 for largest express trains. The author does not define the adjectives used in connection with these coefficients. [The real difficulty in devising satisfactory train resistance formula is that it must be comprehensive enough to provide for a vast number of entirely unknown conditions.—EDITOR.]

"Some Data on Hoisting Hooks." By J. L. Bacon.—Hooks bent from round stock were compared, by the author, with others made in accordance with Townes' formula. The paper records the results and also shows the effect of case hardening or carbonizing upon the strength of the hooks. The author concludes that hooks made of round iron and carbonized are about as strong as the hooks of the same shape flattened according to Townes' formula, while a plain hook carbonized and hardened is from 40 to 50 per cent. stronger than either.

"The Bursting of Emery Wheels." By C. H. Benjamin.—Several years ago the author was consulted in litigation occasioned by the bursting of an emery wheel and determined to extend his experimental study of the bursting of fly wheels to cover emery wheels also, using apparatus which is already on record before the society. Fifteen commercial emery wheels of various makes were tested to destruction. They were selected from stock without the knowledge of the manufacturers as to the purpose for which they were required. Six different makes were obtained, the working speeds varying from 1,150 to 1,400 revolutions. For a diameter of 16 ins., this gives a peripheral velocity of about 5,000 ft. per minute. The fineness of emery, the working speeds, bursting speeds and factors of safety are stated in tabular form. The lowest factor of safety was 5.71 and the highest 13.10, the conclusion being that as the bursting speeds varied from 2¼ to 3½ times the working speeds, the wheels were all safe at the speeds recommended and would not have burst under ordinary conditions. The author, however, recommended a factor of safety not less than 10.

"Fits and Fitting." By S. H. Moore.—This is an investigation of recent practice in forcing, shrinking, driving and running fits and limits for limit gauges. It is a study of previously existing information reduced to usable form. The available matter in the form of scientific investigation and records of successful practice was the basis of the paper. The data were transferred to rectangular co-ordinates and put into the shape of curves. Representative curves indicating good practice were then constructed and these are given in the paper in connection with formulæ. We shall refer to this paper again.

"Drawing Office Equipment." By J. McGeorge.—While concerned chiefly with a large drawing office, such as that of the Wellman-Seaver-Morgan Company, of Cleveland, with which the author is connected, this paper presents a high ideal of drawing office equipment, which is equally important in smaller establishments. The paper boils down the generalities and brings out particularly "the necessity of saving the manual and mental drudgery of the draughtsman and thereby getting the highest possible efficiency." The author reflects severely upon the policy of using poor equipment in drawing offices where such important and expensive work is done. A case is cited where a saving of $360 per year is made by use of the cheapest material. The salary account of that office was $100,000 per year, and probably $10,000 to $15,000 was lost through the saving of the small amount mentioned. The first point for consideration was *light*. Good daylight was essential, and for artificial lighting the Nernst lamp was strongly recommended. The light should be thrown to the ceiling and diffused from white walls and ceilings. Next came ventilation, a matter which was becoming more generally appreciated. An exhaust fan system was recommended. Good tables were absolutely necessary. The author's company were about to use a new and excellent table shown by means of an engraving. Good business policy required 100 sq. ft. per man for floor space. The paper concluded with a very strong argument in favor of the use of the Universal Drafting Machine. (See AMERICAN ENGINEER, December, 1902, page 389.) The paper includes plans of several large and well appointed drawing rooms.

"A Graphical Daily Balance in Manufacture." By H. L. Gantt.—This paper shows the entire feasibility of knowing exactly all the work that has been done in a large plant one day, before noon of the next day, and of securing a perfect balance of work in order to lay out that afternoon in a logical manner the work for the next day. Such information is stated to be "far more important than an improved tool steel or a new set of piece-work prices. It should be established before the introduction of either of these in order that we may have some means of measuring the gain made by their introduction, and it should remain after they are introduced, to show that a forward step once taken is never retraced. The author stands for exact knowledge of what is being done as the basis for improvement, and the paper indicates the simple details of a comprehensive and inexpensive method of securing this information as employed at the Schenectady works of the American Locomotive Company. He would make the accounting system a potent factor in helping production instead of

being critical only. This is an important paper, and every shop officer and manager or superintendent should embody something of the sort in his practice.

"Mechanics of Air Brake Systems." By H. G. Manning.—Credit for originating and bringing up to its present high efficiency the present day compressed air-brake systems all over the world is given by the author to George Westinghouse, and to him alone. The paper presents some of the principal parts of the Westinghouse, the New York and the Pennsylvania air-brake systems. It will present to the mind of the reader some of the differences in engineer's valves, pumps and triple valves made by these manufacturers.

"Test of an Hydraulic Elevator System." By R. P. Bolton.—This paper describes tests made on a passenger elevator in a department store in New York, in order to ascertain whether the contractor's guarantee was met. The elevators had a carrying capacity of 3,000 lbs. and a speed of 300 ft. per minute at that load. Each car was given a load of 1,000 lbs. From the results the following figures are taken:

Per car mile, fuel	32.32	lbs.
Per car mile, steam	231.5	"
Per car mile, water pumped	6.025	gals.
Live load actually lifted, per car mile	2,640,000	foot-lbs.
Live load actually traveled, per car mile	5,280,000	"
Live load lifted per pound of fuel	813,700	"

MOTOR-DRIVEN MACHINE TOOLS.

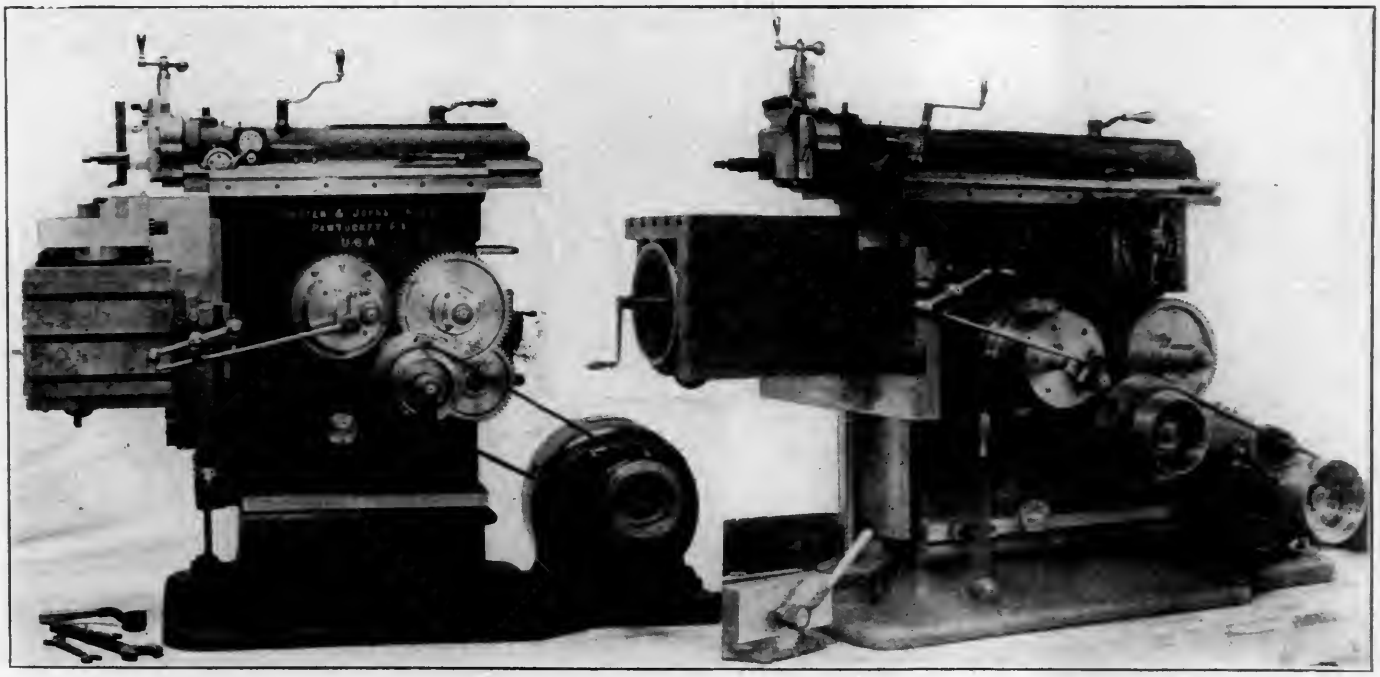
THE LATEST PRACTICE IN APPLYING INDIVIDUAL DRIVES TO SHAPERS.

No greater influence has ever been brought to bear upon the development of shapers than that resulting from the introduction of the new "high duty" steels for cutting tools, together with the modern variable-speed systems of driving whereby the operators are enabled to very quickly change cutting speeds and so secure the fullest possibilities from the great endurance of the tool steels. The importance of motor driving in this connection is rapidly gaining ground with users of machine tools, and in many establishments important reductions in the per-pound labor costs have been made. Several instances of such motor-drive applications to shapers by the more progressive tool builders are presented below.

Notable among recent applications of motor driving to shapers are the two machines illustrated in the engraving presented above, which illustrate two universal shapers, built by the Potter & Johnston Machine Company, Pawtucket, R. I., thus equipped. The methods of mounting the motors in these instances are ideally simple, the motors being carried by mere extensions of the shapers' bases, to which they are rigidly bolted. The drive is by belt and cone pulleys, having three steps in each case for limited variations of speed.

The motors are General Electric Company constant-speed direct-current motors on both machines. They are controlled by starting boxes conveniently located on the rear of the machine frames. It is usually feared, in drives of this type, that trouble might be given by the short belts occasioned by the closeness of the pulley centers, but the experience of the Potter & Johnston Company has proven this to be not so. The belts are run fairly tight and give no trouble.

The upper engraving on page 270 illustrates an application of motor driving to the 21-in. back-geared shaper built by the American Tool Works Company, Cincinnati, Ohio. The motor is mounted on a substantial base directly back of the column to which it is bolted. The bolt holes in the base are prolonged into slots to permit of adjustment of the motor for tightening the belt for the drive.



BELTED DRIVES UPON 15-IN. AND 24-IN. UNIVERSAL CRANK-SHAPERS—BUILT BY THE POTTER & JOHNSTON MACHINE COMPANY. CONSTANT-SPEED MOTORS.—GENERAL ELECTRIC COMPANY.

The motor is of the constant-speed type, running at a high speed, the variation in cutting speed of the ram being obtained through a pair of properly proportioned cone pulleys, one of which is mounted directly on the motor shaft and the other on a stud on the column. The cone on the stud carries a pinion which meshes into a large gear on the end of the driving shaft. This arrangement is advantageous for belt driving, as it necessarily gives the belt a high velocity.

The advantages of this method of drive are obvious. The constant-speed motor gives maximum efficiency at minimum cost, speed changes being obtained mechanically; no power is dissipated through resistances, nor is a motor of extra size required, as would be the case where a variable-speed motor is installed. The belt runs at the highest permissible velocity, which permits of reduction in size of all parts connected with

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

SEMI-ANNUAL MEETING, SARATOGA, JUNE 23 TO 26.

The time of holding the semi-annual meeting this year precludes the presentation of an account of the discussions in this issue. They will be referred to next month. Brief statements concerning those of the papers most likely to interest our readers are presented below:

"The Steam Turbine from an Operating Standpoint." By F. A. Waldron. This paper contains a description and record of tests of the first Westinghouse-Parsons turbine to be put into practical operation outside of the works of the builders. It is a most gratifying record of satisfactory experience. This is believed to be the most important paper of the meeting because of the prominent place now taken by the steam turbine and the value of the opinions expressed. Extracts from the paper will appear in these columns. The author brought out the noteworthy fact that with an evaporation of 8.7 lbs. of water per pound of coal a brake horse power can be delivered to the pulley of a motor for the consumption of 2.5 lbs. of coal. This allows 5 per cent. for banking. With average non-condensing engines three times this amount of coal would be necessary if the engines were distributed about the plant. Special attention is directed to the interesting table of motor tests accompanying this paper.

"Alternating Current Motors for Variable Speed." By W. I. Slehter. Variable speeds may be obtained with alternating current motors. The author reviews the existing information on this subject and discusses the various methods of obtaining speed control. This paper ought to lead those having alternating current installations to consider the advisability of securing variable speeds for machinery which requires it, and its effect is to add an argument in favor of alternating installations, or, to express it in another way, this discussion shows that the lines between alternating and direct current propositions cannot be as sharply drawn as heretofore. This paper will be presented in our columns.

"Train Resistance, a Rational Formula." By J. B. Blood.—The author expresses the need of a formula which will permit of fitting motive power to its work "with a nicety." He recommends the following formula:

$$R = A + BM + \left(C + \frac{D}{T} \right) M^n$$

Where R = resistance in lbs. per ton, M = speed in miles per hour, T = weight of train in tons, n = exponent = 1.8, A = coefficient of sliding friction, B = coefficient of rolling friction, C = coefficient of side resistance, D = coefficient of head and stern resistances.

The values of these coefficients are given in the paper as follows: A = 3 for heavy freight trains, 4 for average passenger trains, 5 for heavy large electric cars, 6 for medium electric cars, 7 for light electric cars; B = 0.15 for light track construction, 0.12 for heavy track construction; C = 0.0016 for ordinarily constructed cars, and 0.0014 for cars with vestibules; D = 0.25 for cars with small cross section, 0.30 for electric cars with medium cross section, 0.35 for large suburban cars, and 0.40 for largest express trains. The author does not define the adjectives used in connection with these coefficients. [The real difficulty in devising satisfactory train resistance formula is that it must be comprehensive enough to provide for a vast number of entirely unknown conditions.—EDITOR.]

"Some Data on Hoisting Hooks." By J. L. Bacon.—Hooks bent from round stock were compared, by the author, with others made in accordance with Townes' formula. The paper records the results and also shows the effect of case hardening or carbonizing upon the strength of the hooks. The author concludes that hooks made of round iron and carbonized are about as strong as the hooks of the same shape flattened according to Townes' formula, while a plain hook carbonized and hardened is from 40 to 50 per cent. stronger than either.

"The Bursting of Emery Wheels." By C. H. Benjamin.—Several years ago the author was consulted in litigation occasioned by the bursting of an emery wheel and determined to extend his experimental study of the bursting of fly wheels to cover emery wheels also, using apparatus which is already on record before the society. Fifteen commercial emery wheels of various makes were tested to destruction. They were selected from stock without the knowledge of the manufacturers as to the purpose for which they were required. Six different makes were obtained, the working speeds varying from 1,150 to 1,400 revolutions. For a diameter of 16 ins., this gives a peripheral velocity of about 5,000 ft. per minute. The fineness of emery, the working speeds, bursting speeds and factors of safety are stated in tabular form. The lowest factor of safety was 5.71 and the highest 13.10, the conclusion being that as the bursting speeds varied from 2¼ to 3½ times the working speeds, the wheels were all safe at the speeds recommended and would not have burst under ordinary conditions. The author, however, recommended a factor of safety not less than 10.

"Fits and Fitting." By S. H. Moore.—This is an investigation of recent practice in forcing, shrinking, driving and running fits and limits for limit gauges. It is a study of previously existing information reduced to usable form. The available matter in the form of scientific investigation and records of successful practice was the basis of the paper. The data were transferred to rectangular co-ordinates and put into the shape of curves. Representative curves indicating good practice were then constructed and these are given in the paper in connection with formulæ. We shall refer to this paper again.

"Drawing Office Equipment." By J. McGeorge.—While concerned chiefly with a large drawing office, such as that of the Wellman-Seaver-Morgan Company, of Cleveland, with which the author is connected, this paper presents a high ideal of drawing office equipment, which is equally important in smaller establishments. The paper boils down the generalities and brings out particularly "the necessity of saving the manual and mental drudgery of the draughtsman and thereby getting the highest possible efficiency." The author reflects severely upon the policy of using poor equipment in drawing offices where such important and expensive work is done. A case is cited where a saving of $360 per year is made by use of the cheapest material. The salary account of that office was $100,000 per year, and probably $10,000 to $15,000 was lost through the saving of the small amount mentioned. The first point for consideration was *light*. Good daylight was essential, and for artificial lighting the Nernst lamp was strongly recommended. The light should be thrown to the ceiling and diffused from white walls and ceilings. Next came ventilation, a matter which was becoming more generally appreciated. An exhaust fan system was recommended. Good tables were absolutely necessary. The author's company were about to use a new and excellent table shown by means of an engraving. Good business policy required 100 sq. ft. per man for floor space. The paper concluded with a very strong argument in favor of the use of the Universal Drafting Machine. (See AMERICAN ENGINEER, December, 1902, page 389.) The paper includes plans of several large and well appointed drawing rooms.

"A Graphical Daily Balance in Manufacture." By H. L. Gantt.—This paper shows the entire feasibility of knowing exactly all the work that has been done in a large plant one day, before noon of the next day, and of securing a perfect balance of work in order to lay out that afternoon in a logical manner the work for the next day. Such information is stated to be "far more important than an improved tool steel or a new set of piece-work prices. It should be established before the introduction of either of these in order that we may have some means of measuring the gain made by their introduction, and it should remain after they are introduced, to show that a forward step once taken is never retraced. The author stands for exact knowledge of what is being done as the basis for improvement, and the paper indicates the simple details of a comprehensive and inexpensive method of securing this information as employed at the Schenectady works of the American Locomotive Company. He would make the accounting system a potent factor in helping production instead of

ing critical only." This is an important paper, and every op officer and manager or superintendent should embody mething of the sort in his practice.

"Mechanics of Air Brake Systems." By H. G. Manning.—Credit for originating and bringing up to its present high efficiency the present day compressed air-brake systems all over the world is given by the author to George Westinghouse, and to him alone. The paper presents some of the principal parts of the Westinghouse, the New York and the Pennsylvania air brake systems. It will present to the mind of the reader some of the differences in engineer's valves, pumps and triple valves made by these manufacturers.

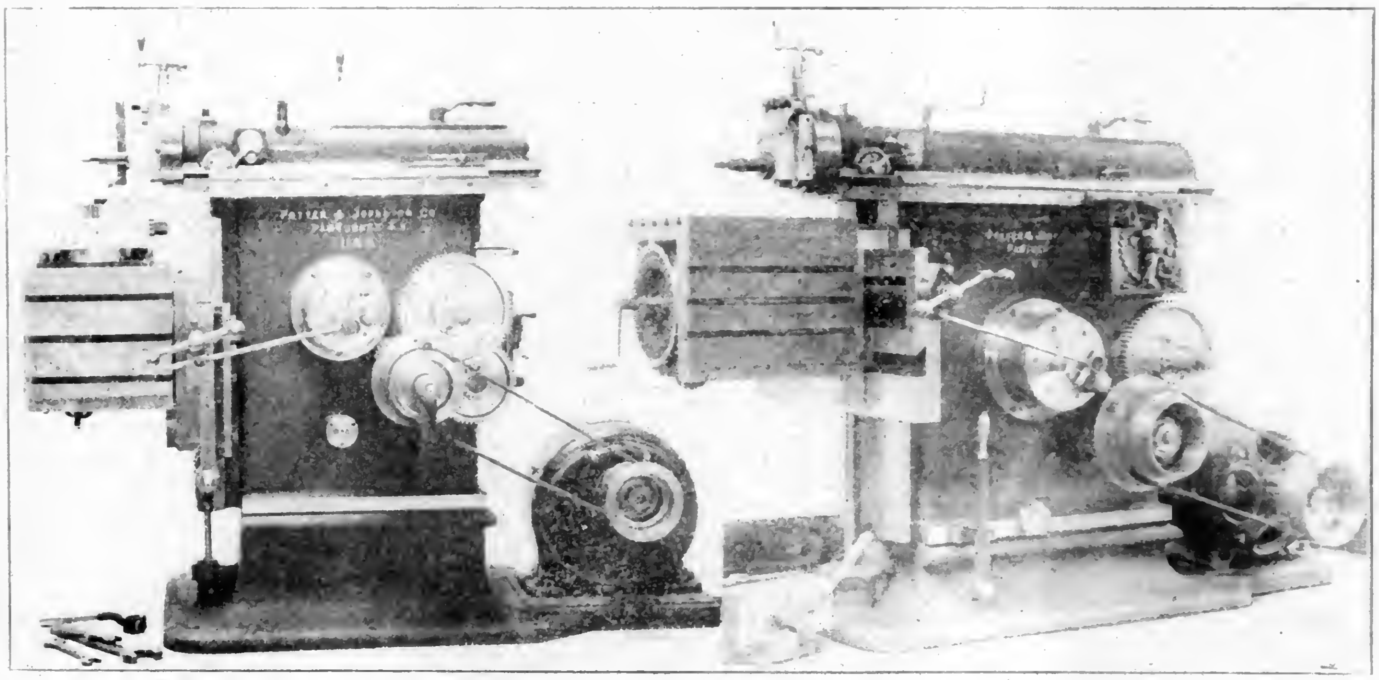
"Test of an Hydraulic Elevator System." By R. P. Bolton.—This paper describes tests made on a passenger elevator in a department store in New York, in order to ascertain whether the contractor's guarantee was met. The elevators had a carrying capacity of 3,000 lbs. and a speed of 300 ft. per minute at that load. Each car was given a load of 1,000 lbs. From the results the following figures are taken:

Per car mile, fuel	32.32	lbs.
Per car mile, steam	231.5	"
Per car mile, water pumped	6,025	gals.
Live load actually lifted, per car mile	2,640,000	foot lbs.
Live load actually traveled, per car mile	5,280,000	"
Live load lifted per pound of fuel	813,700	"

MOTOR-DRIVEN MACHINE TOOLS.

The Latest Practice in Applying Individual Drives to Shapers.

No greater influence has ever been brought to bear upon the development of shapers than that resulting from the introduction of the new "high duty" steels for cutting tools, together with the modern variable-speed systems of driving whereby the operators are enabled to very quickly change cutting speeds and so secure the fullest possibilities from the great endurance of the tool steels. The importance of motor driving in this connection is rapidly gaining ground with users of machine tools, and in many establishments important reductions in the per-pound labor costs have been made. Several instances of such motor-drive applications to shapers by the more progressive tool builders are presented below.



BELTED DRIVES UPON 15-IN. AND 24-IN. UNIVERSAL CRANK SHAPERS. BUILT BY THE POTTER & JOHNSTON MACHINE COMPANY. CONSTANT-SPEED MOTORS.—GENERAL ELECTRIC COMPANY.

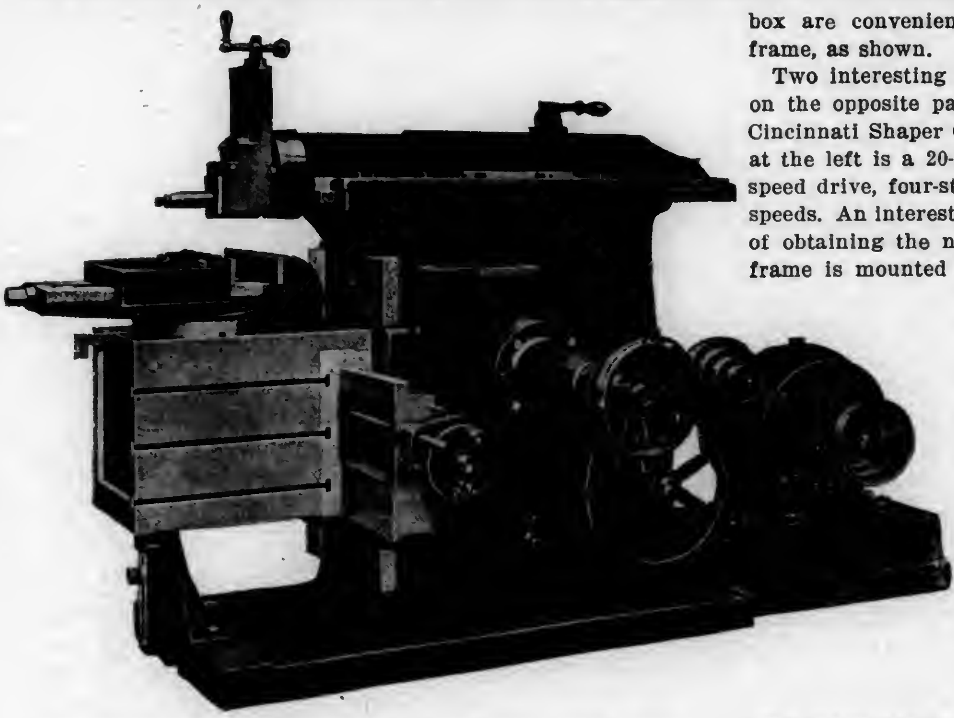
Notable among recent applications of motor driving to shapers are the two machines illustrated in the engraving presented above, which illustrate two universal shapers, built by the Potter & Johnston Machine Company, Pawtucket, R. I., thus equipped. The methods of mounting the motors in these instances are ideally simple, the motors being carried by mere extensions of the shapers' bases, to which they are rigidly bolted. The drive is by belt and cone pulleys, having three steps in each case for limited variations of speed.

The motors are General Electric Company constant-speed direct-current motors on both machines. They are controlled by starting boxes conveniently located on the rear of the machine frames. It is usually feared, in drives of this type, that trouble might be given by the short belts occasioned by the closeness of the pulley centers, but the experience of the Potter & Johnston Company has proven this to be not so. The belts are run fairly tight and give no trouble.

The upper engraving on page 270 illustrates an application of motor driving to the 21-in. back-geared shaper built by the American Tool Works Company, Cincinnati, Ohio. The motor is mounted on a substantial base directly back of the column to which it is bolted. The bolt holes in the base are prolonged into slots to permit of adjustment of the motor for tightening the belt for the drive.

The motor is of the constant-speed type, running at a high speed, the variation in cutting speed of the ram being obtained through a pair of properly proportioned cone pulleys, one of which is mounted directly on the motor shaft and the other on a stud on the column. The cone on the stud carries a pinion which meshes into a large gear on the end of the driving shaft. This arrangement is advantageous for belt driving, as it necessarily gives the belt a high velocity.

The advantages of this method of drive are obvious. The constant-speed motor gives maximum efficiency at minimum cost, speed changes being obtained mechanically; no power is dissipated through resistances, nor is a motor of extra size required, as would be the case where a variable-speed motor is installed. The belt runs at the highest permissible velocity which permits of reduction in size of all parts connected with

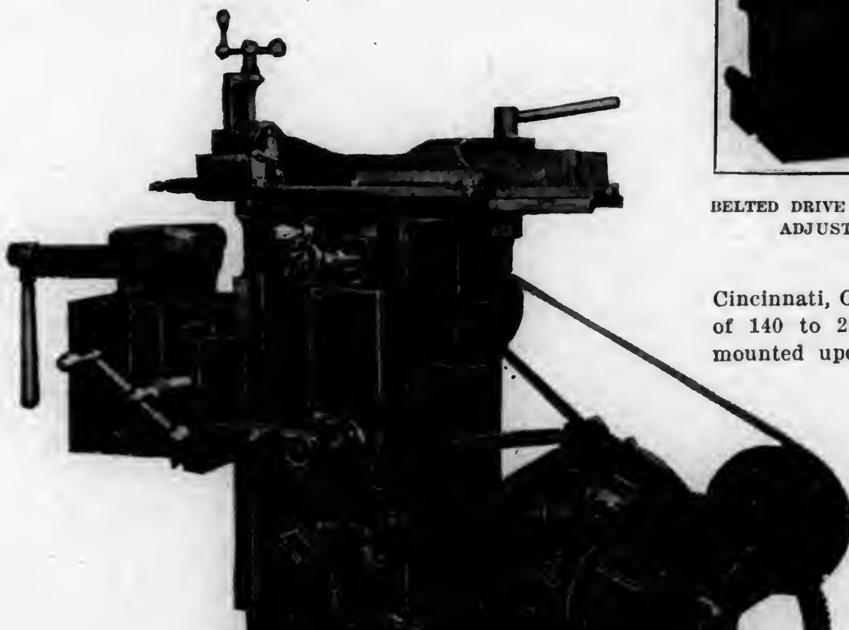


HIGH-SPEED BELTED DRIVE UPON A 21-IN. BACK-GEARED CRANK-SHAPER.—THE AMERICAN TOOL WORKS COMPANY.

the drive, making the whole an exceptionally compact arrangement and leaving space around the shaper free for the operator.

Directly below is illustrated an interesting motor-drive upon a 14-in. shaper which is in use at the works of the Triumph Electric Company, Cincinnati, Ohio. In this case also the motor is located at the rear of the shaper, being mounted upon an extension of the base. The drive is through a belt and cone pulleys having four steps for a limited number of speed changes, the motor operating at constant-speed at its best advantage. In this case also no trouble is experienced with the short belt.

The motor is 1½-h.p. constant-speed direct-current motor of the back-geared type, built by the Triumph Electric Company. It operates at a speed of 1,000 revolutions per minute, the gear reduction being one-quarter so as to drive the back shaft at 250 revolutions per minute. The main switch and starting



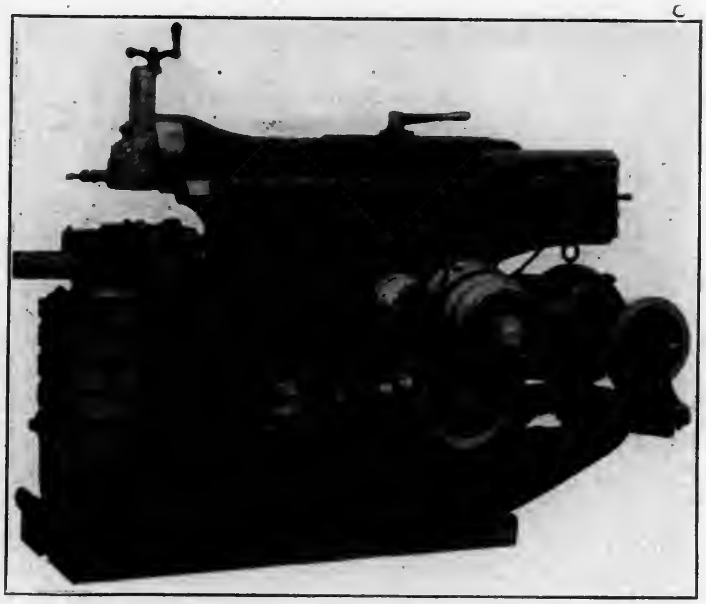
BELTED DRIVE UPON A 14-IN. CRANK-SHAPER AT THE WORKS OF THE TRIUMPH ELECTRIC COMPANY.—1½-H.P. BACK-GEARED TRIUMPH MOTOR.

box are conveniently located at the side of the machine's frame, as shown.

Two interesting motor-driven shapers are illustrated above on the opposite page. These shapers were both built by the Cincinnati Shaper Company, Cincinnati, Ohio. The one shown at the left is a 20-in. back-geared shaper and has a constant-speed drive, four-step cones being used for a limited range of speeds. An interesting feature of this application is the method of obtaining the necessary speed reduction; the cone on the frame is mounted upon a bracket and has a rawhide pinion upon its shaft which meshes with the large gear upon the drive, as shown below. This is particularly advantageous, as it permits relatively high belt velocities upon the cones.

The motor used here is a constant-speed direct-current motor built by the Jantz & Leist Electric Company, Cincinnati, Ohio. It is wound for 500 volts and operates at 1,200 revolutions per minute. The motor is mounted upon an extension of the shaper's base by guide strips which have slotted holes to permit of readily adjusting the belt tension.

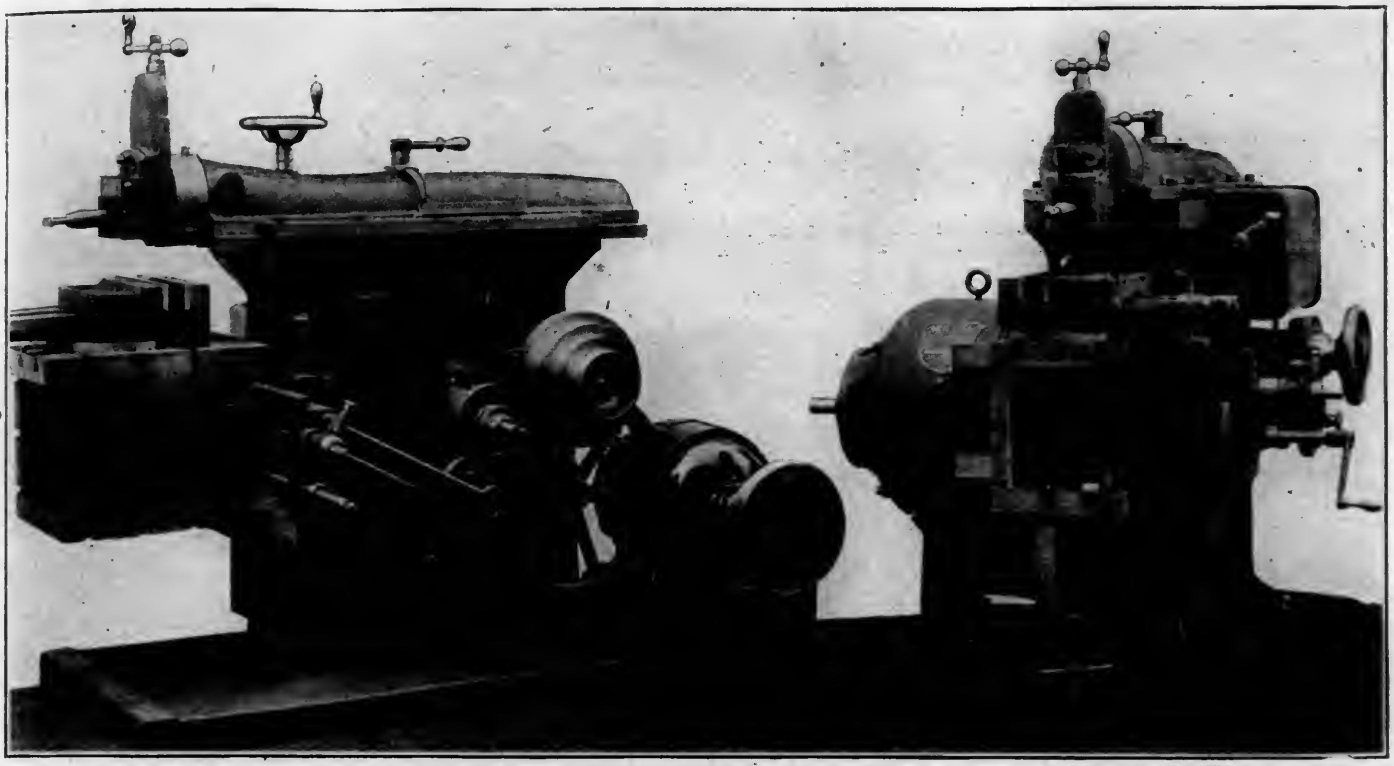
The shaper shown at the right in the above-mentioned engraving is a 16-in. back-geared shaper built by the Cincinnati Shaper Company. This machine has a variable-speed drive, the motor operating upon the multiple-voltage system. The motor, which is a type N motor, made by the Bullock Electric Manufacturing Company,



BELTED DRIVE UPON A 24-IN. QUICK-STROKE CRANK-SHAPER, WITH ADJUSTABLE MOTOR SUPPORT.—GOULD & EBERHARDT.

Cincinnati, Ohio, has a capacity of 1½ h. p. and a speed range of 140 to 280 revolutions per minute. It is in this case mounted upon a bracket at the left of the frame so as to permit of direct connection of the armature to the machine's drive. The controller for the variable speeds is conveniently located at the right of the ram, as shown in the illustration.

In this connection we desire to call attention to the excellent application of individual driving to a 26-in. rack shaper built by the Cincinnati Shaper Company, which was described on page 103 of our March, 1903, issue. This installation has been in use at the Collinwood Shops of the Lake Shore & Michigan Southern Railway for about one year with gratifying success, particularly with reference to the flywheel drive.



HIGH-SPEED BELTED DRIVE UPON A 20-IN CRANK SHAPER.—JANTZ & LEIST MOTOR.

MULTIPLE-VOLTAGE VARIABLE-SPEED DRIVE.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

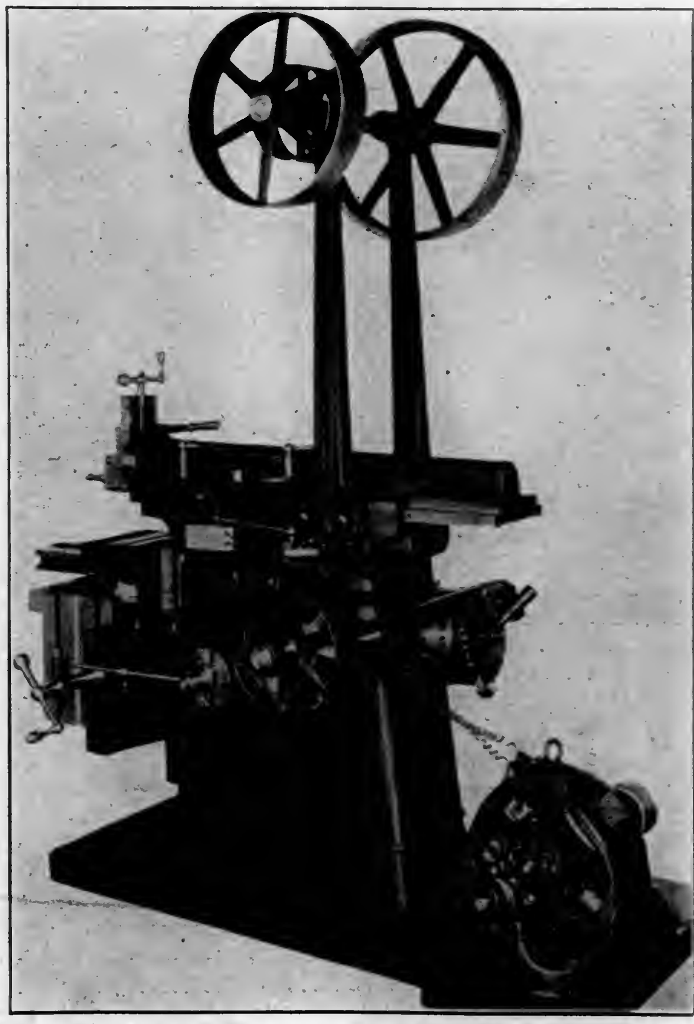
MOTOR-DRIVEN SHAPERS.—CINCINNATI SHAPER COMPANY.

Gould & Eberhardt, of Newark, N. J., have taken a prominent stand in advocating the application of individual motor driving to shapers, and make the claim that it has decided advantages over the method of group driving from line shafting. On the opposite page is illustrated the new 24-in. quick-stroke Gould & Eberhardt shaper arranged for motor driving. The motor mounting in this case is very interesting—it consists of an extension bracket bolted to the machine's frame, to which is pivoted a rocking base for the motor. This base is provided with an adjusting screw, as shown, to permit of tilting the base to tighten the belt.

Four-step cones are used for obtaining different speeds, making eight changes with the back gear, and the Eberhardt stroke and cone scale is applied, so that the workman is always informed as to the proper step on the cone for a desired ram stroke. The belt cones are carried on stationary sleeves, the sleeves taking the belt strains, thus relieving the pinion shaft of all save the actual gear driving load. The control switch and the starting box for the motor are conveniently located upon a tablet at the rear of the frame.

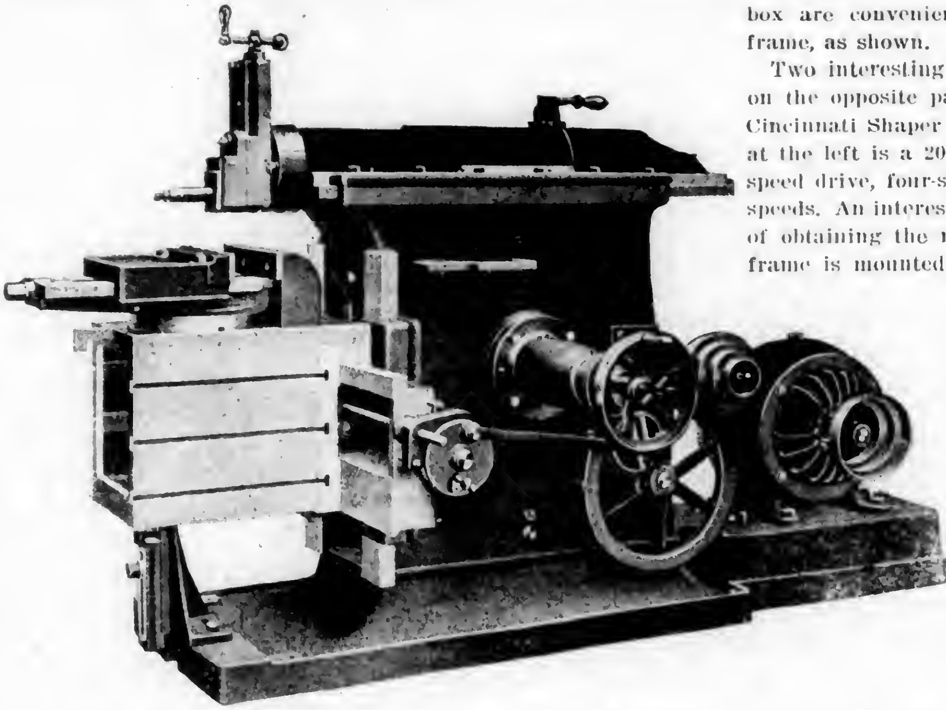
The illustration at the right presents a very interesting type of motor drive for a shaper. The shaper illustrated is a 24-in. triple-geared rack shaper built by the John Steptoe Shaper Company, Cincinnati, Ohio. The drive is from a constant-speed motor, used in connection with a countershaft carried by upright brackets upon the tool. The motor is bolted on an extension of the base and is belted from the motor to the large pulley on the countershaft. This pulley is purposely made heavier than ordinary, and, as stated by the makers: "Is intended to act as a fly-wheel, *holding the full load on the motor longer than would otherwise be the case and thus doing away with sudden variations of the load.*" (In this connection permit us to call attention to the editorial entitled: "Fly-wheels on Planer Drives," on page 227 of our June issue.)

The builders state that this method of driving by a motor gives a smooth, easy motion to the ram and can be fully controlled from the usual position of the operator, as, although the starting box is at the rear of the column, the motor may be stopped, if necessary to stop the machine for some time, by throwing out the switch on the side of the column; while for purposes of examining, and placing or removing work, the ram may be stopped instantly at any point desired by the belt shifting lever. The motor used in this instance is a 500-volt direct-current constant-speed Westinghouse motor of 2-h.p. capacity and operates at 1,200 revolutions per minute.



NOVEL BELTED DRIVE WITH FLY-WHEEL UPON A 24-IN. RACK SHAPER. JOHN STEPTOE SHAPER COMPANY.

2-H.P. CONSTANT-SPEED MOTOR.—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.



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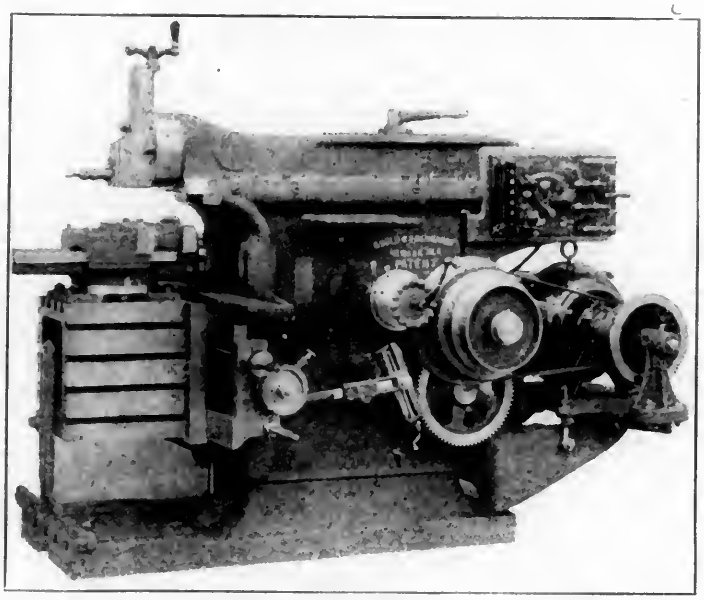

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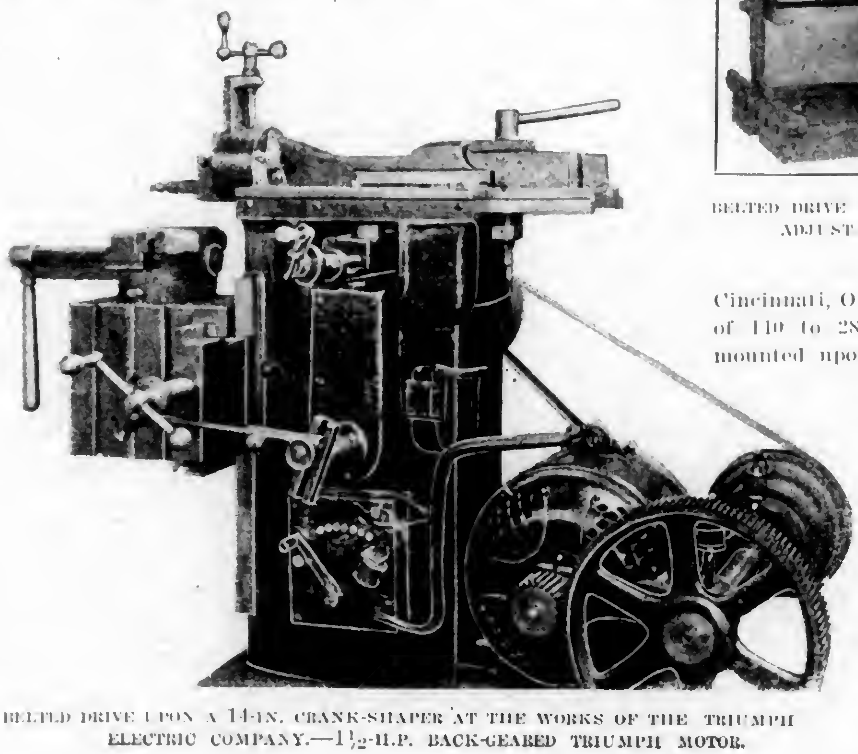

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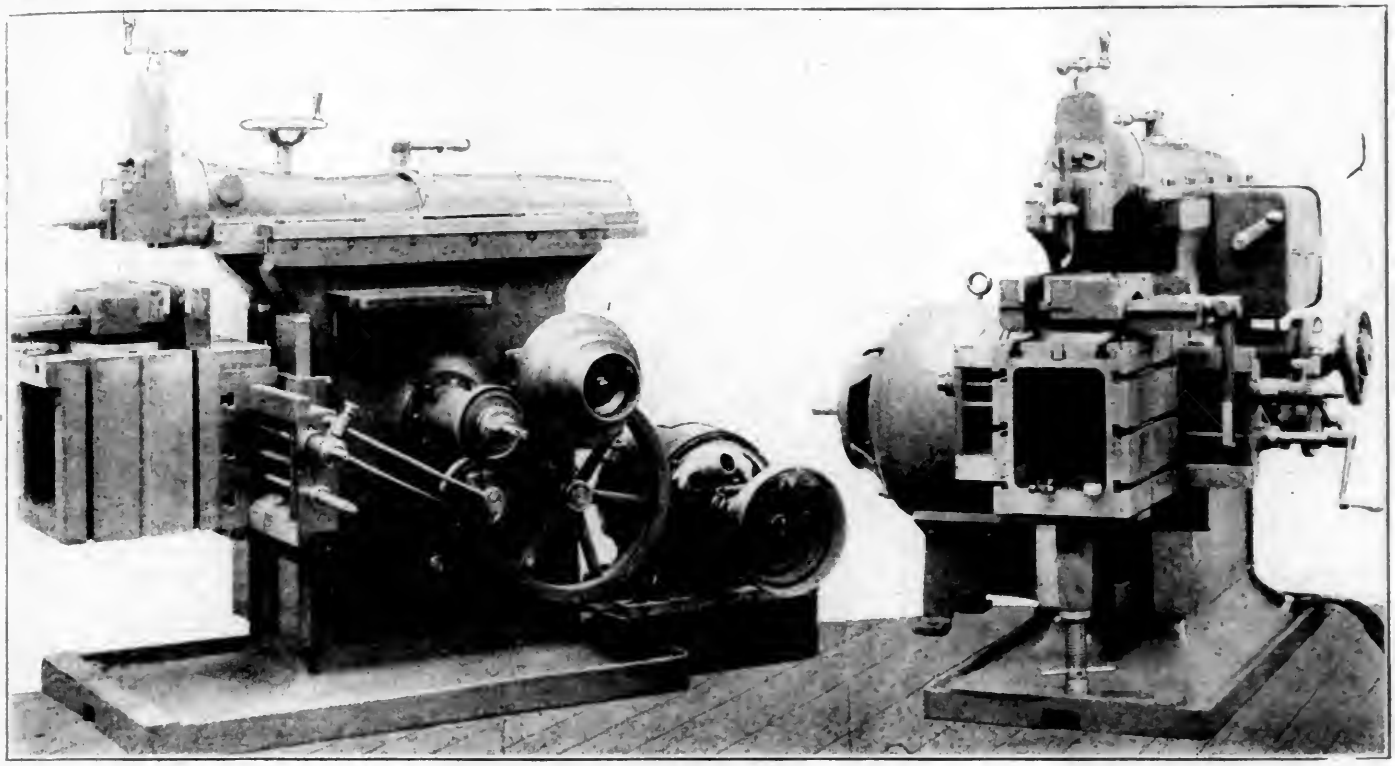

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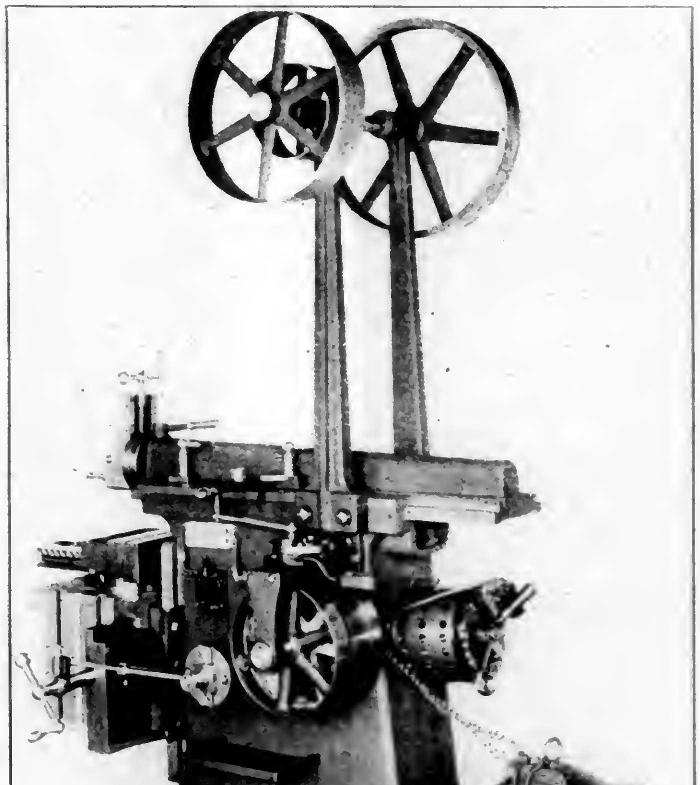

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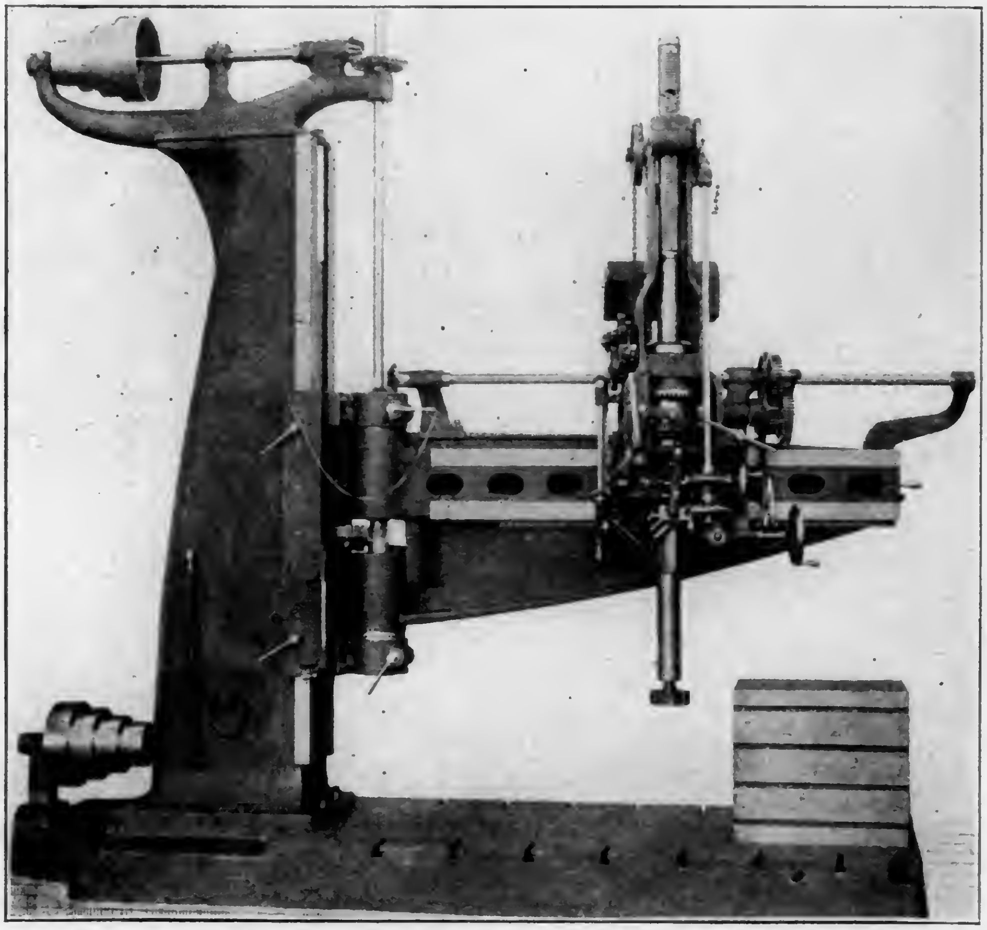
2-H.P. CONSTANT-SPEED MOTOR.—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.

A NEW SPECIAL TAPPING RADIAL DRILL.

FOSDICK MACHINE TOOL COMPANY.

The accompanying engraving is an illustration of a new type of 7-ft. special tapping radial drill, which has recently been designed by the Fosdick Machine Tool Company, Cincinnati, Ohio. It embodies a particularly heavy and rigid design, being intended to meet the special requirements of locomotive builders, railroad repair shops and other large shops in boring cylinders, drilling, reaming and tapping large holes, etc.

One of the distinctly new features of this tool is that it has



84-IN. SPECIAL TAPPING RADIAL DRILL FOR LOCOMOTIVE MACHINE WORK.—FOSDICK MACHINE TOOL COMPANY.

a positive thread-cutting attachment for 8, 10, 12 and 14 threads per inch for heavy tapping. The tapping attachment is of a special design, constructed of hardened tool steel teeth clutches. The tool has also a variable-speed feed device, giving four drilling feeds, varying from .014 to .0079 per revolution. The spindle is 3-15-16 ins. in diameter, and has 30 ins. traverse. These features make it possible to take care of certain classes of large work, heavy drilling, tapping, etc., to much better advantage than is possible on the plain radial drill.

The gearing used upon this drill is of steel throughout, all bevel gears being planed from the solid. An important feature is that the thrusts of the arm, of the spindle and of the elevating screw are taken by ball thrust bearings. The improved quick return used upon the head permits of engaging the power feed instantly.

SPECIFICATIONS.

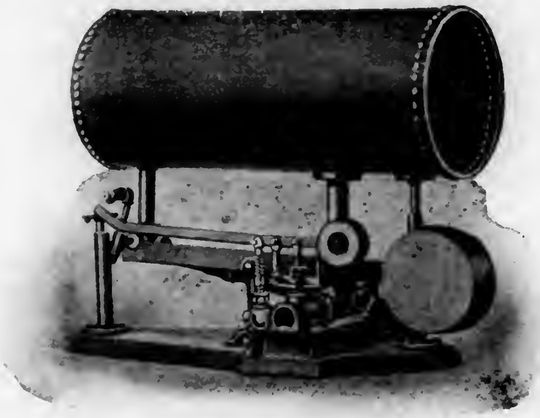
Drills to center of circles of diameter	172 ins.
Greatest distance from spindle to base	90 ins.
Traverse of spindle	30 ins.
Traverse of saddle	65 ins.
Traverse of head on arm	57 ins.
Table	24 x 27 ins.
Height of drill	13 ft.
Total height with arm raised	18 ft. 6 ins.
Floor space	14 ft. 1 in. x 17 ft. 4 ins.
Weight, net	20,000 lbs.

These tools are being used by the American Locomotive Company for drilling cylinders, guide yokes, link hangers, rockers, crossheads, etc., and also in connection with a box tool for hubbing off the bosses on rocker-arm hubs, link-hanger hubs, valve-gear transmission bars, etc. They are also being used by the Locomotive and Machine Company of Montreal, Ltd., Montreal, Que.; the Wellman-Seaver-Morgan Company of Cleveland, the Stilwell-Bierce & Smith-Vaile Company of Dayton, Ohio, and the Laidlaw-Dunn-Gordon branch of the International Steam Pump Company, Cincinnati. The latter two concerns are using them on pump work, employing the special spindle speeds to excellent advantage for screwing in pump-valve seats.

THE MOREHEAD RETURN TRAP.

The Morehead return trap is constructed of steel, the heads and longitudinal seams being closely riveted and caulked, to withstand any pressure carried on the boiler without leakage. It is simple in construction and has no rubber joints to blow out or leak, and only one valve, which is on the outside. All working parts are on the outside, in plain sight, and easily accessible.

This trap is located 6 ft. or more above the water-line of the boiler. The water from the condensing surfaces is forced by the pressure of the steam behind, through a pipe leading to the trap, with a swing check valve close to the latter. As soon as sufficient water has entered the receiver to overcome the counter-balance weight the receiver tilts down, allowing the water to pass through the discharge pipe, at the same time open the steam valve, which has a pipe connected with the dome of the boiler. By thus equalizing the pressure on the surface



THE MOREHEAD RETURN STEAM TRAP.—AMERICAN BLOWER COMPANY.

of the water in the receiver with that in the boiler the water flows by gravity into the boiler. As soon as the receiver is empty it tilts back as before and again refills. The trap is prompt in opening and closing, its action being entirely due to gravity. When once set up it requires no further attention. It takes the water from the condensing surfaces,

whether they are above or below the water level in the boiler, and automatically returns it to the boiler at the temperature due to the pressure at which the steam is condensed. There is no outlet by which the steam can be wasted. The trap is said to be quick and positive in delivering the water into the boiler against any pressure, and regardless of fluctuations of pressure. It supplies all the water needed in the boiler from the main water pipe (providing there is enough pressure on the main to lift the water to the trap) thus performing the duties of a pump or injector. It is reported to operate equally well with high or low pressure coils, or coils using exhaust steam, allowing no condensation to collect in them. For a boiler plant of 200 h.p. having an efficiency of 65 per cent. and an evaporation of 6,900 lbs. of water per hour, from and at 212 degs., under average conditions, the saving effected by a Morehead return trap for a year is more than twice the cost of installing one large enough to handle such a plant.

Where a return trap of this kind is not employed, the usual way of handling condensation is by means of a pump. A comparison of the two methods shows many points of advantage in favor of the former. A pump will not lift water at temperatures exceeding 212 degs.; a Morehead return trap will do so. A pump consumes an extravagant amount of steam to do a very little work. For example, an ordinary duplex boiler-feed pump requires from 90 to 120 lbs. of steam per horse-power hour and a common slide-valve engine seldom consumes less than 40 lbs. per horse-power. The pressure is admitted to the surface of the water, and is automatically shut off before the tank is empty. The steam used is only such as is condensed by the heat passing from it into the water in the tank, which is all put back into the boiler.

It is claimed that a Morehead return trap requires practically no attention; needs no lubrication; will not race or run away; is noiseless; requires little room and no foundation. Full information may be obtained by addressing the American Blower Company, of Detroit, Mich.

The Kennicott Water Softener Company announce that they have secured the services of Professor W. M. Bruce, formerly of the University of Chicago, who has assumed full charge of their laboratories.

The Gold Car Heating and Lighting Company has brought suit in the United States Circuit Court, Northern District of Illinois, at Chicago, Ill., against Egbert H. Gold, for infringement of United States letters patent No. 388,772 for car-heating apparatus.

We are requested to direct the attention of railroad managers to the special service division of the Edward Smith Company which is stated to have been very successful in connection with reorganizations of various departments of railroads in reducing expenses and raising the operation of departments to the highest possible standards. The Edward Smith Company employs mechanical experts who enter the service of the railroad as regular employees. They investigate conditions and furnish detailed reports with recommendations as to possible methods for improvement. Information and references will be furnished on application to Edward Smith, vice-president and general manager of the Edward Smith Company, Detroit, Michigan.

Mention has been made several times recently in this paper concerning the rapid strides which have been taken by the Pressed Steel Car Company of Pittsburg in the manufacture of pressed steel cars, and it is with pleasure that we note that this company has built and shipped, up to and including May 29, 1903, 100,467 cars. This figure represents the actual number of cars which are in service to-day manufactured by the Pressed Steel Car Company, which includes steel cars as well as wooden cars for which steel underframes have been furnished. This company has for some time past shipped over 120 cars per day from its McKees Rocks and Allegheny plants, using in the manufacture of these cars from 45,000 to 50,000 tons of steel plates per month. From the present outlook all previous records which have been established in car building will be eclipsed. It is estimated that the output this year will exceed 38,000 finished cars. Large orders for cars, both wooden and steel, have been received for early delivery, in addition to a large number of pressed steel body and truck bolsters, freight car and engine tender trucks, as well as other pressed steel specialties for wooden and steel cars.

MASTER MECHANICS' ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.

DRAWBAR AND BUFFER ATTACHMENTS FOR USE BETWEEN ENGINE AND TENDER.

INDIVIDUAL PAPER BY HENRY BARTLETT.

Editor's Note.—After commenting upon the uncertainty and non-uniformity of practice in these attachments the author points to the great magnitude of the stresses involved and indicates the fundamental principles of correct construction. He discusses the frame and strength of drawbars, the lifting effect of offset bars, the effect of springs and slack in the buffers, and then presents two possible solutions. The paper is an excellent one, giving detail drawings of a large number of draft connections. It concludes with the following summary:

In want of any actual information as to the behavior, hopeful or otherwise, of an adaption of M. C. B. coupler principle between engine and tender, I am disposed therefore to propose as a final recommendation:

1. That the provision for buffing stresses take the best possible form of an adjustable wedge.
2. That the drawbars be straight, even at the expense of redesigning foot plates and tender front draw castings in new work and renewals.
3. That the drawbar pinholes be provided with ample bearing area.
4. That an elongated eye be provided at one end to prevent the bar from ever coming into compression.
5. That sufficient stock be provided at both ends to prolong the wear in the pinholes.
6. That 4,000 lbs. be aimed at as the working stress with straight bars.
7. That the drawbar shall be of the best materials, and that a limit shall be set to the repetition of welding a bar in repairs.

Finally, that a system of inspection of drawbars and related gear at stated frequent intervals be instituted and rigorously observed.

RECENT IMPROVEMENTS IN BOILER DESIGN.

COMMITTEE—D. VAN ALSTINE, G. R. HENDERSON, T. W. DEMAREST, O. H. REYNOLDS, JOHN PLAYER.

Editor's Note.—This valuable illustrated review of present tendencies in boiler design indicates the universal desire to secure maximum capacity, the efforts of the past year having been in this direction. The wide firebox now rapidly assuming a position as a standard of construction was responsible for the great addition to the length of tubes. A table of dimensions of recent boilers shows the tendency toward larger heating surfaces both here and abroad. The use of the Drummond water tube firebox construction (see AMERICAN ENGINEER, March, 1899, page 79) was prominently mentioned in the report and attention was called to the progress of super-heating both here and in Europe. The committee laid special stress upon the fallacy of crowding boilers with tubes to the detriment of circulation. The report concludes with the following opinions with regard to boiler practice:

The committee has reached the conclusion that boiler troubles have increased in proportion to the increase in size and steam pressure of boilers.

Those roads having very little trouble with old boilers are having very little more with modern boilers, and those which have always had a good deal by comparison, are having a good deal more with their modern boilers. Poor water is evidently the chief cause of boiler troubles, though it is evident that poor coal, severity of service, contracted water spaces, etc., contribute to an aggravation of the trouble. It would appear also that in poor water the incrusting solids are not always the governing factor, but that other solids also have their effect in producing cracked side sheets and leaky flues.

One horse-power for 3 sq. ft. of heating surface seems to be about all that can be safely relied upon as a regular performance with water ordinarily found in the middle and western States, but this can be improved upon where water is of better quality.

There seems to be no question but that the wide grate is at least 10 per cent. more economical than the narrow, in burning bituminous coal, but that its economy while running is to some extent offset by its comparative waste of coal while standing idle on side tracks or at terminals, and this waste appears to increase proportionally to the increase in grate area.

No conclusion could be made as to the maximum grate area which a fireman can economically fire, but it no doubt depends on the quality of the coal, and for a clinkering coal would appear to be in the neighborhood of 45 sq. ft.

Treating water in locomotive tenders is undoubtedly beneficial, provided it is followed with frequent blowing down and washing out, in that it retards the formation of scale and overheating. The quality of the water may be so poor, however, as to require so much soda ash or other reagent and hence so much washing out that the good effects of the soda ash are offset by the bad effects of too much washing out.

The correct method of treating water appears to be in station tanks so that solid matter does not get into the boiler, but even by this treatment there seems to be danger of making the water so alkaline as to foam badly.

The committee would call attention in this connection to retarded circulation to such an extent that flues and back-flue sheet

are frequently and highly overheated. Wide fireboxes, poor coal and poor firing admit large volumes of cold air against overheated flues and sheets and the wide range of temperature to which flues are subjected loosens them circumferentially and draws them in and out longitudinally. Flues are frequently found so loose that they can be shaken in the sheet. Short pieces of flue rolled into a piece of ½-in. firebox steel in the usual manner, heated to a dull red and suddenly cooled require a considerable number of heatings to make them loose. This is not exactly a parallel case to flues in a boiler, but the conditions are somewhat similar.

An experiment was made to determine the temperature surrounding flues by plugging certain flues at both ends with asbestos and placing asbestos plugs 2 ft. apart throughout the length of the flue with two pieces of fusible metal in each space, one piece melting at 410° to 420° and the other from 440° to 450° Fahr. The results are given in Table No. 3 (not reproduced), and show that the temperature surrounding the flues was considerably above the temperature of saturated steam at 220 lbs. at the back end and in the case of upper flues it was higher all the way through.

If the surrounding temperature is so high in a flue thus plugged it must be still higher about flues through which fire is passing, and it is probable that the temperature at flue sheet is very much higher. There is no evidence to prove that a flue will not stand a considerable amount of overheating without leaking, but it would appear that those that are leaking are subjected to too high and too great a range of temperature.

It is only necessary to have a sufficient body of water against side sheets to reduce cracked side sheets and broken stay bolts to a minimum. It should follow that flues can be spread far enough apart to stop their leaking, but the spreading of flues reduces the heating surface very rapidly and the widest spacing the committee has knowledge of, namely, 3½-in. centers for 2-in. flues, has not cured the trouble.

In conclusion the committee would recommend the appointment of a committee for the ensuing year to further investigate the question of leaky flues.

PISTON VALVES.

COMMITTEE—F. F. GAINES, R. P. C. SANDERSON, F. H. CLARK.

From the replies received it would seem that the type of valves more generally favored is either the hollow internal admission or hollow external admission, and while there is a fair proportion of solid internal admission valves there are very few solid external admission valves in use, unless we consider the piston valve used on the Vauclain compound as being of this type.

The D. & H. Co. state: "In the spring of 1902, Messrs. Campbell and DuBois, seniors of Cornell University, made a comparative test in freight service in Class E-2 and E-3 engines. The engines were laden proportionately to tractive power. Deductions gathered from this test show a saving on the piston valve engine of 1.8 per cent. due to valve. The piston valves were new, and the slide valves were recently shopped." While not so stated, this economy is apparently due to steam distribution, and as the percentage of gain is so small it is questionable if, after the elimination of errors of observation, there would remain any advantage. Several other roads express preferences, but without giving reasons so fully.

As regards the ratio of diameter of cylinder to cylinder of valve both in simple and compound engines there seems to be a large variation between the maximum practice and the minimum practice. In simple engines the high pressure varies from 1.66 to 2.1. For the Vauclain compound system the high pressure varies from 1 to 1.38, and for the low-pressure cylinder from 1.67 to 2.30. The variation in the other types of compounds is not so marked, due to fewer replies being received covering these types. It is the opinion of the committee that the lower ratios indicate the better practice and that the higher ratios should only be used on freight and switching engines.

As regards the value of the various types of relief valves from water it is not thought that the valve in cylinder head fulfills its function in the manner that it is expected to. It has been the experience of one road that these valves, after being in service for a short time, corrode, or through other causes fail to lift at the pressure at which they are set, and that they are of but little value as relief from water in cylinders. As to relief when drifting, very few of the by-pass valves or relief valves are thoroughly successful where the speed is high.

Various types of packing rings are in use, as well as rings of the same style varying greatly in their dimensions. The rectangular cast-iron snap ring, together with the cast-iron "L" ring, appears to be used in the majority of cases, while for the rectangular rings about ⅝ by ½ in. and for "L" rings ⅝ by ½ in. seem to be the prevailing sizes. In some few of the valves provided with followers heavier rings are used, and it is questionable if the prevailing practice is not too light rather than too heavy. As regards the various advantages of the rectangular and "L" shaped rings, it would seem that the rectangular rings generally have the advantage of strength, longer life, cheaper cost and cheaper maintenance, while to offset this, the "L" ring, especially on high-speed engines, gives a very much better port opening with less wire drawing of steam. The "L" ring naturally has a greater unbalanced surface than the rectangular ring, and it is the experience of one road that it wears both itself and the chamber very much more rapidly than the rectangular ring. Your committee believes that in most designs the extension part of the "L" ring projects too far.

Relative to exhaust effect, the Chicago, Burlington & Quincy states as follows: "We have made experiments on valve friction of internal admission piston valves of both hollow and solid types. With the solid valve, cards taken show that at slow speed there is an excessive push forward on the valve when exhaust first opens."

The Boston & Maine states as follows: "We have made no test on piston valves for friction. We observed that when our first consolidation engines arrived, they soon began to sound badly out of square, the indicator diagram showing that the valves were not cutting off equally, yet no discrepancies could be found in the valve setting or motion work. The defect was attributed to the removal of pressure from back end of the valve by the valve stem, the greater pressure on the front end keeping the slack all taken up in one direction and allowing valve to keep as far back as possible. This condition existed for speeds up to 30 miles per hour, above which, apparently, the inertia of the parts overcame the unbalanced force. The inequalities of the exhaust sound increased with increased slack in the motion work. The trouble was overcome by enlarging the back head of the valve by an area equal to area of the valve stem."

No experiments seem to have been made with a view to determining the steam lost due to worn rings, and judging from remarks made at the topical discussion on this subject at last year's meeting, it would seem that there is a wide variation of opinion as to the amount of this loss. One road states that while having made no accurate tests to determine the steam loss due to wear of packing rings, two of the master mechanics who had made shop tests on this point, are of the opinion that the rings can easily represent a loss of 15 per cent. over steam consumption with rings in first-class condition.

Only two roads replying to the circular acknowledge having had any experience with the new type of American balance slide valve. One of these states that two engines are equipped with most excellent results. The other has had four engines equipped for about a year's time, and, with the exception of some minor difficulties in the start which were later overcome, the results have been very good. The valve (see AMERICAN ENGINEER, April, 1902, page 125) has both double admission and double exhaust features, and while no indicator cards have ever been taken to show how much has been gained by this feature, there can be no question but that it is an appreciable factor. Your attention is also called to the fact that with this type of valve, all balancing parts are stationary and not subject to wear, and that in two different ways a very short steam port may be obtained. One of these will be found illustrated in connection with the valve mentioned in the Appendix, showing cylinders upon which it is used, and how, by making wide shallow exhaust cavity in cylinder, a short steam port was obtained. The other method by which this can be accomplished is to use inside admission, as there is nothing in the way of balancing this valve equally as well for inside as for outside admission, although it is believed the latter has not yet been tried. Notwithstanding the large size of this valve as illustrated, in connection with 210 lbs. of steam, the engine can be handled with a full throttle with ease, showing that valve is perfectly balanced. It also has the advantage of providing for relief from over pressure in the cylinders by lifting in the same manner as the ordinary slide valve, and on account of the double exhaust feature there must be considerable decrease in back pressure, which is evidenced to a certain extent by the very short, sharp exhaust.

The replies as to the chief advantages of piston valve seem to be fairly uniform and consist, in the main, of better balancing, which includes ease of handling and decrease in wear and tear of motion work. In addition, some replies give less cylinder clearance, better steam distribution, less cost for maintenance, shorter steam passes, decreased back pressure, better distribution, larger port openings; and on the four-cylinder compound the fact that the piston valve really takes the place of the two valves, in that it distributes the steam to both high and low-pressure cylinder, greatly simplifies the motion work and the number of parts. It is questionable if all the advantages claimed are real and tangible, as it seems that some of these attributes can be obtained equally as well or better with other types of valve. It would seem that the question of lubrication is not a settled one. The reply of one road states that where engines with piston valves have to drift for long distances the question of properly lubricating the piston valve becomes a very serious problem, and it is hoped that a discussion of this paper will bring out some more definite information on these points. It would seem that the reason for the growing favor in which the piston valve is held is due largely to reasons as given by one of the roads in reply to the circular, as follows: "Our reasons for taking up the piston valve are that with the increased size of engines and steam pressure the ordinary balance 'D' slide valve increases in size proportionately, and while we may balance the valve in the same ratio as the valves on the smaller engines, the difference in unbalanced surface increases with the size of the engine. This increases the wear on the valve and link motion, eccentrics and straps, and increases the work necessary on the part of the engineman to handle the engine." The foregoing reasons probably cover the situation, the Lake Shore stating that on a very careful test an economy of about 5 per cent. was shown, which they considered due to back pressure and perhaps slightly to decrease of amount of compression.

In the Appendix which accompanies this report will be found the tests referred to on various types of valves and valve bushings, which illustrate very thoroughly the practice of this country as regards the piston valve. Some of the modifications as to design of ring will be found very interesting.

From the replies to some of the questions it is very evident that little or no data is available on some of the subjects brought up in connection with the piston valve. Your committee, therefore, recommends:

First: That tests be made to determine the amount of loss of steam due to worn packing rings. Such tests should include the various types of rings illustrated in the report.

Second: That tests be made to determine whether the steam or the exhaust rings are the most responsible for the decreased efficiency due to wear.

Third: That the question of proper lubrication of piston valves when drifting be more thoroughly investigated.

Fourth: The attention of the committee being called to the question of valve setting in connection with the piston valve, after it was too late to include it in the circular, by one road stating that with identical valve motions, to obtain equal work, modifications in the piston valve setting must be made, it is suggested that further investigation be made along this line.

LOCOMOTIVE FRONT ENDS.

COMMITTEE—H. H. VAUGHAN, F. H. CLARK, A. W. GIBBS, W. F. M. GOSS, ROBERT QUAYLE.

Your Committee on Locomotive Front Ends, appointed to assist the AMERICAN ENGINEER AND RAILROAD JOURNAL in the tests being carried out at Purdue University along the lines of

(a) Proper dimensions for standard front end,
(b) Elimination of cinder valves,
(c) Elimination of the diaphragm,

begs to report as follows:

Since the conclusions derived from the tests being carried out by Purdue University, under the arrangements made with the AMERICAN ENGINEER, were not immediately available when this committee was appointed, it was deemed inadvisable to hold an early meeting as instructed by the Executive Committee, and action was therefore deferred until Professor Goss presented a complete report. On receipt of this it was at once seen that a most valuable addition to existing information on the front end problem had been made and that the experiments certainly decided the relations of the stack and nozzle definitely and finally so far as it could be possible to do so on a testing plant. The conclusions are of such importance that we consider they should now be recorded in the report of this committee for the information of the members. The report presented also included a section devoted to a problem for further study. As this outlines as desirable a series of tests and is with one addition entirely concurred in by your committee this section is also included.

The sections above referred to which are reproduced from the AMERICAN ENGINEER are as follows:

Editor's Note—At this point the report presents the Summary of Results constituting Section VII. of the report by Professor Goss, which appeared in the June number of the AMERICAN ENGINEER, followed by Section VIII., Problems for Further Study. The committee report then proceeds as follows:

It might be stated that the engine on which these tests were made had a front end 54 ins. in diameter, and the conclusions adapting the results obtained on this engine to those of a larger size were obtained by considering the diameter of the front end as a unit, and increasing the size of the stack in direct proportion. While this may be a correct method, we feel, since all locomotives recently built or that are liable to be constructed in the future will have front ends of considerably larger sizes, this subject will not be left in a satisfactory condition unless further tests are carried out to confirm or correct this assumption.

We were advised by Professor Goss that it would not be possible to carry out further tests in continuation of the AMERICAN ENGINEER series prior to June, 1903, on account of the conditions at Purdue University, and we also anticipated that considerable difficulty would be experienced in obtaining the use of a sufficiently large engine with the present demand for power. It was, therefore, decided to request those members who formed the original committee organized to assist in the AMERICAN ENGINEER tests to make experiments in service to confirm the results obtained by Professor Goss. The majority were compelled to reply that, owing to the large amount of work then being carried on in their respective departments, they would be unable to assist during the present year and only three series of tests have been carried out. These have only been partially made and the results are not sufficiently complete to present in this report, although it may be stated that they practically confirm the conclusions arrived at on an engine having a front end of the same size as that used at Purdue University, but leave it open to question whether these results are immediately applicable to engines having a considerably larger front end. We are pleased to be able to announce that through the courtesy of one of the members of this association, Mr. J. F. Deems, General Superintendent of Motive Power and Rolling Stock, of the New York Central & Hudson River Railroad and Lake Shore & Michigan Southern Railway, arrangements have been made by which a large modern engine, having a front end 75 ins. in diameter, will be available to allow this series of tests to be completed. This will enable the determination of the correct unit to be used for stack diameters to be made, and a further series of tests carried out along the line recommended by Professor Goss. Your committee, therefore, asks to be continued in order that during the coming year it may carry out the purpose for which it was appointed.

EFFECTS OF TONNAGE RATINGS ON THE COST OF TRANSPORTATION.

INDIVIDUAL PAPER BY C. H. QUEREAU.

There have been indirect savings in operating expenses, due to the use of tonnage ratings, which are not always considered. I refer to the use of the ton-mile basis for statistics, which naturally followed the introduction of tonnage ratings. Previously the almost universal basis of motive power statistics had been the engine-mile. Because the engines made more miles per ton of coal the lighter the train, there was a constant effort on the part of master mechanics and engineers to haul as light trains as possible in order to improve their records, which no doubt in a measure neutralized the efforts of the transportation department to handle as heavy trains as possible, and undoubtedly increased the cost of transportation somewhat, when compared with the possibilities, and was a source of constant friction between the two departments. The ton-mile basis for motive power statistics changed all this, because it was soon demonstrated that the heavier the train, within reasonable limits, the less the cost of coal, wages and repairs per ton-mile, and, therefore, it was to the interest of the motive power men to haul as heavy trains as practicable, thus harmonizing the interests and efforts of the employees of both the transportation and motive power departments.

The ton-mile basis also corrected a number of erroneous conclusions, resulting in a clearer understanding of cause and effect, which no doubt led to economies. A few illustrations will probably make this point plainer than an extended description. The figures given are actual records.

TABLE. I.

	March, 1896.	1897.	Increase Per Cent.
Average miles per engine	2,282	2,289	0.3
Average ton-miles per engine	782,213	972,486	24

Had there been no ton-mile statistics, there can be little doubt the conclusion would have been drawn that the average work done per engine in the two years was practically the same. The ton-mile figures show this conclusion would have been wide of the mark and misleading, and also demonstrate that in this case the use of tonnage ratings increased the work done by the engines 24 per cent., as the class of locomotives was practically the same in the two years.

TABLE II.

DIVISION D.—JANUARY, 1896.

	Miles to Ton of Coal.		Coal per 100 Ton-miles.	
	Lbs.	Per Cent.	Lbs.	Per Cent.
Main line, freight	16.6	100	20.79	100
Branch, freight	14.8	112	67.93	327
Main line, freight	16.6	193	20.79	100
Main line, passenger	32.1	100	33.09	159

Judged by the results on the engine-mile basis, the branch freight engines were using only 12 per cent. more coal than those on the main line. This record was considered very satisfactory indeed, so far as the branch was concerned, as there were a considerable number of heavy grades and curves on it, while the main line was comparatively level and straight, and the conclusion was naturally drawn that it was not much more expensive, so far as fuel was concerned, to operate a mountain district than one on the prairie. But as soon as attention was directed to the figures based on the ton-mile it became evident that the heavy grades and curves of the branch required three and a quarter times as much coal as the main line to do the same amount of work.

In comparing the relative cost of fuel in freight and passenger service, using the engine-mile as a basis, the almost inevitable conclusion was that freight engines used nearly twice as much as passenger engines, but when the basis of comparison was the ton-mile, it became evident that the cost of fuel was practically 60 per cent. greater in passenger service.

The discussion would, however, fall far short of completeness if it did not include another phase of the subject, at least suggest that there is still room for decided improvement and call attention to the fact that tonnage ratings, though a decided improvement over the car ratings, may easily be carried to extremes and result in increased, instead of decreased, transportation costs, and that there is still a wide field for scientific investigation in the matter of locomotive ratings and transportation statistics.

It is very generally assumed that the maximum tonnage a locomotive can handle at a speed of about ten miles an hour is the most economical. I venture to differ from this opinion and will first consider the matter as applying to the conditions which have prevailed throughout the past winter, during which time there has existed practically a freight blockade. Under these conditions the paramount issue, to borrow a political phrase, is to handle the business offered and keep it moving almost regardless of cost; in short, to handle the largest possible number of cars with the power and facilities available.

For the sake of argument and illustration, Table III. is presented. It applies to two divisions; the first 100 miles and the second 200 miles in length, and is based on the following assumptions: First, that it requires four hours to get an engine from its train to the roundhouse, clean its fires, give it necessary repairs, furnish the necessary supplies and have it on its train again; second, that a train of 40 cars will allow an average speed of 10 miles an hour; third, that a reduction of the train from 40 to 35.2 cars, or 12 per cent., will permit an increase in the average speed to 15 miles an hour.

TABLE III.

	100-Mile Division.		200-Mile Division.	
Speed, miles per hour	10	15	10	15
Hours between terminals	10	6.67	20	13.32
Hours at terminal	4	4	4	4
Hours for one trip	14	10.67	24	17.32
Trips in thirty days	51.4	67.5	30	41.6
Cars hauled per trip	40	35.2	40	35.2
Cars hauled per month	2,056	2,376	1,200	1,464
Gain in cars handled per month		320		264
Gain in cars handled per month, per cent.		16		22

These figures show an increase of from 16 to 22 per cent. in the number of cars an engine will handle per month, due to a decrease of 12 per cent. in the number of cars handled per train, and that the longer the division the greater the increase.

The following figures give the percentages of overtime paid engineers and firemen, in relation to their total wages, during June, when there was no special rush of business and the engines available were ample to handle it easily, and during September, when the power was taxed to its utmost capacity:

	Division A.	Division B.
June—Overtime, per cent. of total wages	1.8	2.0
September—Overtime, per cent. of total wages	5.3	4.6

The above shows conclusively that the overtime paid increased from two to three times as much as the business done, as determined by the wages paid enginemen.

The reasons which make it seem more than probable that a reduction of maximum tonnage ratings would decrease the cost of wages per ton-mile apply with equal force to the cost of fuel; not that the cost of fuel while running would be much, if any, greater per ton-mile with the maximum tonnage, but that the longer delays on side-tracks, the longer hours for the train and engine crews and the damage done the fire while pulling out of

side-tracks with the heaviest trains would result in a greater cost of fuel per ton-mile.

I believe the discussion and facts given warrant the conclusion that tonnage ratings which limit the average speed of freight trains to 10 miles an hour, or less, result in a greater cost of transportation and decreased earning power for motive power than ratings which allow a somewhat higher speed. If this conclusion is accepted, it follows that such maximum tonnage ratings produce a higher cost of transportation than is necessary and that the subject is well worth extended, careful and scientific investigation.

The adoption of tonnage ratings for freight trains has reduced the cost of transportation by increasing the average trainload; by reducing the cases of doubling and overtime; by furnishing a basis of common interest for the operating and motive power departments to handle full trains, and by furnishing a fairer basis for judging operating and motive power efficiency.

It seems, however, evident that, as is usual when any new plan has proved beneficial, the pendulum has swung to the opposite extreme and the maximum tonnage ratings are, as a rule, greater than the most economical ratings. At least the evidence at hand warrants systematic and scientific investigation.

ELECTRICALLY DRIVEN SHOPS.

COMMITTEE—C. A. SELEY, H. H. VAUGHAN, T. S. LLOYD, T. W. DEMAREST, L. R. POMEROY.

EDITOR'S NOTE.—Because of its importance this paper is reprinted nearly in full.

Labor-saving seems to be the keynote in the development of most all recent shop plans. Central power plants with all the latest improvements in the way of coal and ash handling machinery, automatic stokers, direct-connected generators and engines, the latter compounded and in some cases condensing, are almost the rule.

The one thing that has contributed most to economize movement of materials is probably the electric traveling crane, lifting a single part or perhaps a whole locomotive, carrying and traversing at desirable speeds over the area covered by the span and travel, hoisting and lowering at will great weights with slow, safe speeds and by auxiliary hoists doing rapid work with light weights.

SYSTEMS AND METHODS.

The designer of a new railroad shop at the present time, in arranging for the generating station and power transmission, is primarily confronted with the problem of deciding which system of electrical power distribution to use, alternating or direct current. Each has its strong advocates, who can advance numerous points in favor of their preferred system, and the question is frequently complicated by local conditions to an extent which makes a decision extremely difficult. It may be necessary to combine in the power plant for the shop a generating station for furnishing current for light or power to other company property, passenger depots, freight houses, car repair plants and similar uses, which are located at a considerable distance. For such purposes alternating current is recognized as being an economic necessity, the cost of copper required to transmit the energy by a low-voltage, direct-current system being practically prohibitive. In another instance the converse of this may be the case: in place of the power plant being required to transmit power to a distance or furnish current for uses other than shop operation, it may receive its power from some outside source, in which case it becomes merely a transforming station to convert the current transmitted, which it may be assumed is a high-potential alternating current, into a form suitable for distribution around the shops. In either case the conditions are identical in one respect: alternating current is necessarily used in the power plant; and in both cases also direct current can also be furnished for shop purposes if desired, either by the use of rotary transformers or motor generators, or, in the first instance, by the installation of direct-current generators for shop use separate from those used for the long-distance transmission.

On the other hand, no long-distance problems may interfere with the choice of a system, the power plant may be entirely used for furnishing energy to a group of shop buildings sufficiently near together to make a low voltage reasonably economical, and whichever system is used is selected solely with reference to its presumed advantages for shop driving.

The above instances represent the effects of local conditions, and while they may be modified in the first examples by the proportion of the total power required for shop or outside purposes, there are evidently two possible general conditions to consider: First, where it is necessary that alternate current be present in the power house; second, where it is not necessarily present.

Now, whichever of these two conditions confronts the designer, there is one important fact which affects the problem in the present stage of the development of the alternate-current motor, namely:

That if electrical speed control is desired, direct current must be used for driving those tools on which it is employed. Assuming, therefore, for the moment, that it is immaterial which system is used for the operation of cranes, transfer tables and driving machinery in groups or constant-speed tools, the really important question to be decided is whether or not electrical speed control in some form or other is desirable. A number of articles on this subject have been written, and they are all worthy of careful perusal and study, but the main question is whether the extra investment necessary is justified by the results obtained. There is no doubt that practically all those connected with shops in which some form of electrical speed control has been installed will speak very favorably with respect to its convenience and the economies resulting from its use, but it certainly entails an extra expense and it is necessary to demonstrate that the benefits received are sufficient to outweigh the additional cost. Usually the possible economies are alone referred to, but a preferable method is to find what increase in output is necessary to compensate for the investment and then discuss whether it may be confidently anticipated that this increase will be obtained. This method of reasoning, which is equally as sound as the other, will be found to fit the case considerably better. It is difficult to obtain figures from which the additional cost of electrical speed control can be definitely determined, and no attempt has been made to obtain them from the various members of this association, although it would be most valuable if they could be furnished in an intelligent form for the proper discussion of this question. For this report the cost figures of the Collinwood shop of the Lake Shore & Michigan Southern Railway, in which the Crocker-Wheeler multiple-voltage system is employed, have been carefully analyzed, and while the results are not accurately applicable to other shops in which the number and character of the tools may vary, and the method of speed control be different, yet remembering that the larger tools in all locomotive shops have a fairly close similarity and that the tools of each description are employed in about the same proportion, it is fair to assume that, while there would be a variation, it would not be important in the gross result, and this assumption will be confirmed by an inspection of the figures.

To ascertain what percentage of increased output must be obtained to justify the application of electrical speed control it is first necessary to formulate the factors that determine the cost per annum of operating a tool. These are as follows:

1. The direct labor charge per diem.
2. The indirect labor charge, including what are generally known as shop expenses, superintendence, power, lighting, etc.
3. Interest and depreciation charge on the cost of the tool.
4. Interest and depreciation charge on the proportion of cost of machine shop and power plant, including generators, etc.
5. Interest and depreciation charge on switchboard, balancers, wiring, motors and controllers, etc.

Of these factors the only one affected by the use of electrical speed control is No. 5, the others being independent of it. The value of them has been estimated for the locomotive shop at Collinwood from the actual figures of the cost of construction as follows:

1. The direct labor for 300 days at $2.80 per diem is $840 per annum.

2. The indirect labor charge may be taken at 20 per cent. This figure is fairly representative of railroad shop practice.

3. Interest may be taken at 5 per cent., depreciation at 10 per cent. This figure may be considered high, but if rate of depreciation is lowered it makes less output necessary to earn the investment on the installation of speed control, and it is desired to be on the safe side. At Collinwood there were 38 tools equipped with multiple-voltage (M. V.) control, total cost $89,644.34, an average of $2,360 per tool. Fifteen per cent. of this sum is $354, the annual charge per tool for this item.

4. The proportionate cost of the building that can be charged against any tool is more or less of a guess; but it is a real charge without question. At Collinwood, where the locomotive-erecting machine shop and boiler shop are under one roof, and the only figures available are the total costs of the entire building, the fairest way is to find the cost per cubic foot of the shop and thus determine the cost of the machine shop itself, dividing this among the various tools in proportion to their cost. This is not exactly correct, but as the more expensive a tool is the more floor space it occupies and the more room is required around it, this method is as fair as possible, and on this basis the cost of the shop, including buildings, heating and lighting apparatus (outside of power plant), cranes, etc., is equal to $1.03 per $1 cost of tool. The proportionate cost of power plant is fairly arrived at by dividing the cost of the plant by the horse-power of output and charging this against the tools in proportion to their consumption. At Collinwood the total cost per horse-power of output is $86, and as the actual consumption of the multiple-voltage tools is 70 horse-power, the amount invested for their operation is $6,020, or $158.50 per tool. The total investment under this heading is, therefore, $2,430 plus $158.50 per tool. On this amount interest may be charged at 5 per cent. and depreciation at 6 per cent., the life being longer than for tools, the total annual charge per tool thus being $284.73, say $284.

5. This item is separated from No. 4, as it includes all charges that vary according to the system of control employed. It includes numerous small items, as follows:

(a) Proportionate part of cost of switchboard and 220-volt feeders in ratio of horse-power consumption of multiple-voltage tools to total, $1,226.

(b) Prorated cost of multiple-voltage portion of switchboard, multiple-voltage transformer and inside feeders in proportion of multiple-voltage tools in machine shop to total, $2,821.

(c) Cost of wiring multiple-voltage tools. This is not by any means an easy figure to determine, but has been estimated very closely by obtaining the total cost of labor and material for wiring all tools in locomotive shop, exclusive of the feeders to the distribution boxes, and dividing the labor by the number of tools wired and the material by the horse-power of tools wired. To allow for multiple-voltage tools, each of them is counted as two tools wired and as being of double the rated horse-power. In this cost there was also included the power wiring in each erecting pit, each pit considered as representing one tool of 5 h.p., which is very closely correct. The result of this calculation is that it cost $480 per horse-power for wiring material, $18.30 per unit tool for wiring labor.

As there were 38 multiple-voltage tools with a total rated horse-power of 270, these amounts are as follows:

38 tools wired at $36.60	$1,380.80
270 × 2 h.p. at $480	2,592.00
	$3,972.80

(d) The cost of motors actually used on the tools, including controllers, etc., $12,150.

The total cost of item No. 5 is, therefore:

(a)	$1,226.00
(b)	2,821.00
(c)	3,972.80
(d)	12,150.00
	$20,169.80

This amount is considered to be subject to 5 per cent. interest and 10 per cent. depreciation, as in the case of the tools themselves, the annual charge thus being $3,025.50, or $79.70 per tool.

Recapitulating the above the average annual cost for operating 38 multiple-voltage tools based on the Collinwood construction accounts would be:

Item 1	$840.00
Item 2	168.00
Item 3	354.00
Item 4	284.00
Item 5	79.70
	$1,725.70

Now, if multiple-voltage had not been employed the only change in the cost of the plant would have been in item 5; the subdivision costs would become as follows:

(a) There would be no change, it remains..		$1,226.00
(b) This cost is avoided without corresponding change.		
(c) This cost becomes:		
38 tools at $18.30	$690.00	
270 h.p. at $4.80	1,296.00	
		1,986.00
(d) The cost of motors required on the various tools, including starting boxes..		7,200.00
Total		$10,412.00

Fifteen per cent. of this amount is $1,561.80, or $41.10 per tool per annum.

The total annual cost of operating a tool is thus $1,725.70 with electrical speed control, against $1.687.10 when driven by constant-speed motors, or an increase of 2.24 per cent. In other words, it is only necessary to obtain an increased output of 2¼ per cent. to justify the extra expense.

There is little doubt that anyone who has been connected with a shop in which some such system has been employed would hesitate for a moment in stating that a saving is obtained many times that required to equal the additional cost, to say nothing of the increase in output, but there are objections to the method usually employed in giving the reasons for this economy which is based on the assumption that the production of a tool is proportional to the cutting speed of the work. It is true that in the average belt-driven tool the various changes of speed usually vary by increments from 40 to 50 per cent., but it does not follow that the work performed need vary in any such ratio. In any given material with the same cutting tool, which is being operated to its capacity, the amount of metal that is removed in a given time depends on three factors—the cutting speed, the feed and the cut. These factors are not independent, but with a given feed and cut the tool will stand up satisfactorily at a certain speed, with a different feed and cut the maximum practical cutting speed will vary, and so on. The law connecting these three factors is not yet properly determined, and will probably vary for different materials. This much, however, can be stated, that for medium steel, such as that used for driving axles, crankpins, etc., the amount of metal that can be removed per minute with the same depth of cut and with feeds varying from 1-8 to 1-20, the speed in each case being adjusted to the limit of the tool, does not vary 15 per cent. This may not be the case so closely with other materials, but it is certain that a variation in the feed affects the permissible cutting in every case, and within the limits of a speed variation of 40 per cent. it is possible to so adjust the feeds and cuts that the amount of metal removed per minute is substantially the same. It might be stated, therefore, that, theoretically, it is unnecessary to have small and easily made variations in speed, but there is another and more important side to this question, the practical one of how to get as nearly as possible the maximum product from a tool. If a machine were employed steadily upon work in which the material were of uniform hardness, and the dimensions of the pieces the same, it would probably be possible to get the same output when the speeds vary by 40 per cent. steps as when they vary by 10 per cent. by the adjustment of the feeds and cuts, but even assuming this to be exactly true, it is a condition that does not obtain in the majority of machine shops, and is practically absent in railroad shops. While machines may be classified as to the work they perform, this work varies quite a little in its dimensions on account of the various forms and sizes of the parts used on different classes of engines, and the materials employed are also subject to considerable variation in their cutting qualities. How is the output determined in such a case? With a belt-driven tool the machinist sets his feed at what he considers is right and runs his tool at a certain speed. He may try the next speed higher, which is an increase of say 40 per cent., and finds it is too high. The result will be that he returns to the original speed and the work proceeds at that rate. It might be possible to use a larger feed, but it is very liable not to be done, and indeed outside of a few lathes feed changes cannot be made rapidly and easily, and in many tools are too coarse to be effective. The speed change, when made by belt cones, takes a certain amount of trouble and is very likely not made as often as advisable. In general, it is difficult to adjust an ordinary belt-driven tool to the best cutting conditions, and it may be taken at the best to run as nearly as the cones allow, say within 20 to 25 per cent. of the maximum on the average. Compare this with a tool having electrical speed control. The work is being cut at a certain speed; by the movement of a lever placed conveniently to his hand, the machinist can increase the speed by from 10 to 20 per cent. up to the point at which it is found possible to run. There is no exertion involved, no time wasted, and, in fact, there was no real excuse for not operating the tool at its proper speed. If the work has two or more diameters, it is a matter of a second or so to change to the suitable speed. If the material is harder than usual, the speed reduction is simply that necessary to meet the condition, and not 25 or very likely 40 per cent. more, as may easily be the case on a belt-driven tool. There the man will not be found to shift the belt whenever a change is necessary, and he can hardly be expected to do so; with electrical control the change is so easily made that he should and can be expected to attend to it. With reasonable encouragement and intelligent control it is fair in this case to assume that on the average the machines can be run within 10 to 15 per cent. of the possible speed, giving an increased output theoretically of at least 10 per cent., and in practical working a great deal more, from the closeness of the speed control alone, to say nothing of the saving of time in the manipulation of the machine resulting from this system. On wheel lathes there is a special advantage, that when one or two hard spots occur in a tire the machine can be slowed over these spots and the speed restored for the balance of the circumference; this feature is not very important to the shop as a whole, but it is quite important on that particular tool.

Another advantage of speed control is the opportunity it affords for a practical system for setting cutting speeds. As above mentioned, this is for any material dependent on the feed and cut, but in the majority of cases in locomotive shops the variation in cut on similar classes of work is not important. Now, by adopting a uniform feed for all roughing work or two uniform feeds, one for heavy and one for light work, the most important variable is eliminated and the speed proposition becomes comparatively simple in place of being exceedingly complicated. The depth of cut is of minor importance within the limits in which it usually varies and by standardizing the feeds it becomes possible to estimate very closely what speed should be employed on different materials and obtaining a satisfactory output is correspondingly feasible. In such a system it is obvious that the ratio of the actual to the possible product depends on the closeness with which the speed can be regulated, and as a difference of 10 or 15 per cent. in the speed is sufficient to ruin a tool in a few minutes or allow it to run for an hour or more, it is evident that it should be controlled by at least that variation.

In general it may be stated that while close electrical speed regulation may not be theoretically necessary, it presents a practical method of increasing the output from shop machinery that cannot be approached by the old belt-and-cone pulley, and that this increase in output should largely outweigh the slight additional cost, and in any shop where this small increase in outlay can be made in order to effect a substantial economy in operation, in other words, in any shop that is laid out on reasonable business principles, some form of speed control should be applied.

If this proposition is assented to, the use of direct current to a greater or less extent follows as a matter of necessity in the present state of the electrical art, for no contractor is yet prepared to figure on alternating-current variable-speed apparatus, and the point next necessary to determine is the extent to which it is advisable to apply this principle. The factor affecting this chiefly is the extent to which it is commercially advisable to direct-connect tools. If it were decided to direct-connect all tools, an inspection of the figures above presented will show that the limiting factor affecting the application of speed control is not the size of the tool, it is the wages of the operator; the smaller the tool and the less the horsepower required to drive it, the less is the additional expense of applying electrical speed control and there is consequently but little difference in the increase in output required to compensate for the additional investment. On a tool costing $500 and requiring 3 h.p. to drive it the items, calculated as above, are as follows:

Item No.	With Speed Control.	Without Speed Control.
1	$840.00	$840.00
2	168.00	168.00
3	75.00	75.00
4	66.00	66.00
5	69.00	34.50
Total	$1,218.00	$1,183.50

a difference of $34.50, or 2.8 per cent.

The wages of the operator are thus the most important factor, as if, in the case of this tool, they were decreased to one-third the amount the increase in output required would become 5.2 per cent. even at that figure; however, the difference would render the question one of the type of tool and general convenience, and the extent to which direct-connection is advisable is thus the most important. At Collinwood tools were direct-connected for three reasons:

1. Where they were located under cranes to allow of their being placed in the most convenient positions and to avoid countershaft supports interfering with the crane service.
2. On tools above 3 h.p. where the advantages of speed control were considered sufficient to justify it.
3. Where tools were in isolated positions and expense of line and countershafting would exceed cost of applying motors.

The remainder of the tools in the machine shop, 103 in all, are group-driven, and the cost of installing these tools has been analyzed to show how it compares with the cost of direct-connected on one assumption, namely: that no additional price would be demanded by the builders in supplying their tools with suitable attachments.

The 103 tools are driven in eleven groups, the total tool horsepower being 242.5; to drive these tools the group motors have a total of 202.5 h.p., which is larger perhaps than necessary, but was considered advisable.

The cost of the driving arrangement was as follows:

Eleven group motors	$4,550.00
Wiring eleven group motors at $18.30	191.30
Wiring 202½ h.p. at $4.80	972.00
Countershaft supports, line shafts, pulleys, etc	6,667.00
Belting	3,881.00
	$16,261.30

Had these tools been direct-driven the cost would have been as follows:

One hundred and three motors	$12,340.00
Wiring 103 tools at $18.30	1,884.90
Wiring 242½ h.p. at $5.40	1,164.00
	$15,388.90

This result may appear surprising, but it is even more favorable to the direct-driven estimate than it appears. The roof construction must be appreciably heavier when it is expected to support countershafting than would be the case if simply required to cover the building. Additional members must be incorporated, but this expense we are not in a position to estimate at present. Then no charge is made against belt-driven tools for belt shifters and the cost of applying the belting, which for 103 tools is quite an expense. It would be interesting to obtain figures on the cost of maintenance of belting in this connection. The cost at Air Line Junction shop, a woodworking plant on the Lake Shore & Michigan Southern, has been obtained and found to be 25 per cent. per annum for material alone. This expense would certainly be less in a machine shop, but can be safely estimated to be equal to the increased amount of repairs to the motors. To enable these figures to be fairly understood, it should be stated that at Collinwood the countershaft supports are 6-in. channels, bolted together by separators and bolted to the under side of the roof structure, which was arranged to permit of this without drilling any holes for bolts or other fastenings. The structure on the whole is, therefore, not expensive, and if a cheaper form of support had been adopted the influence in the total cost would not have been sufficient to make belt connection the cheaper. These costs, it must also be understood, refer to a machine shop, where the tools are closely placed and group-driving appears in its most favorable light. In a wood mill or boiler shop, where tools are widely placed, a very rough estimate will show the economy of direct-connection, as in such a case it is far cheaper, to say nothing of the saving in power by not running long and heavy line shafts to drive a few tools intermittently.

The whole question is up to the machine tool builders. If they can furnish tools which can be direct-driven for the same price as when belt-driven, which is largely a question of preparing their designs to meet the demand, then it will cost no more to direct-drive tools than it does to belt-connect them in groups, and when this can be said the advantages of individual driving will make this practice preferable. It is not necessary at this time to go over the many desirable features of this system of power distribution, the flexibility it allows in shop arrangement, the absence of belts and overhead line and countershafting, and other economical advantages will certainly lead to the use of direct-connection unless the cost is prohibitive, and it would certainly appear from the above discussion that with the adaptation of machine tools, the introduction of suitable designs, not only will this not be the case, but that the converse will be true. While it is at this time impossible to make that statement, yet it can be said that direct driving should certainly be employed so far as it is not rendered prohibitive by the cost of motor application, and it would then follow from the earlier portion of this report that electrical speed control should also be largely employed.

There are at present in use a number of different systems of electrical speed control, all of which are probably satisfactory in operation. They have had in the past one decided feature by which they might be classified, the extent to which it was thought necessary to vary the speed of the motor, some systems employing a speed variation of 1 to 2 or 4, others a decidedly larger range of from 1 to 5 or 8. The question is one of the size of motor desirable to employ to drive any given tool and is thus partly commercial, the larger motor required for a wide speed variation being of course more expensive, and partly one of convenience, the smaller range systems requiring additional gear trains on many tools, which can be avoided by increasing the speed variation of the motor, and conversely the larger motors are inconvenient to apply and occupy valuable room in the shop. It may be safely stated that this question is being gradually settled as experience is developed and that a range of 1 to 3 or 4 will be very generally agreed on as the largest it is advisable to obtain by electrical means.

This range is being now obtained under two distinct systems, one in which three wires are used, giving voltages in the ratio of 1 to 2, the other, in which four wires are used, giving voltages in about the ratio of 1, 1 1-3, 1 2-3, 2. It would be possible of course to obtain three combinations of voltages by the use of three wires, but there would be but little advantage in this, unless a greater range than 4 to 1 is required, and so need not be considered. In both these systems intermediate speeds between those at which the motor runs under normal conditions at the various voltages are obtained by the use of field and armature resistance, the difference between them thus becoming the extent to which this form of control is employed. There is, however, a considerable difference between the results obtained by field and armature regulation; the former does not affect the speed-maintaining qualities of the motor, and the extent to which it is advisable to use it depends in its effect on the commutation and internal loss of the motor. Armature regulation, on the other hand, depends on its stability on a uniform load being carried by the motor, a condition that does not obtain in the machine-tool driving. If sufficient resistance is introduced into the armature circuit to reduce the speed 20 per cent. at full load, the speed will be but slightly reduced at no load, while if the motor is working at 100 per cent. overload, as it may easily be doing for short periods, the speed will be reduced approximately 40 per cent. in place of 20 per cent. Such a condition is frequently found in practice and it is doubtful whether regulation of speed by armature resistance should be allowed to a greater extent than 8 or 10 per cent. on account of this action. This does not apply to motors operating cranes or similar machinery, and on account of this action, by which the voltage across the motor terminals is reduced when any heavy loads are taken, the use of a certain amount of armature resistance may be recommended on planers and other tools in which a large amount of power is taken at the instant of reverse. On a test of a 42 x 42-in. planer, at the Collinwood shops, it was found that the introduction of resistance equal to 20 volts at full load reduced the current taken at the instant of reversing 50 per cent., without seriously affecting the speed during the cutting stroke. As this class of tools is the one giving most trouble when direct-driven, it would appear advisable in all cases to insert a small amount of resistance in the current to obtain this action. In general, however, the above remarks hold good, and a variation of 10 per cent. is the limit to which this class of regulation should be used, or the speeds obtained by it will not be reliable.

On the three-wire system it is therefore necessary to obtain the speeds intermediate between those obtained from the direct voltages by field regulation up to a point that is within 10 per cent. of the higher voltage speed, or, in other words, a speed variation of 80 per cent. must be obtained in this way. This was previously thought impossible, the maximum practical increase in this method have been assumed to be about 30 to 40 per cent. During the past year or so, motors have, however, been developed that allow of this amount of regulation, and with this improvement the three-wire system becomes a serious rival to the four-wire. These motors, which are special, are stated to develop a constant horse-power over a range of 100 per cent., so that, commencing, for instance, at a speed of 250 revolutions per minute at 110 volts, the speed is increased, by field weakening, up to 500 revolutions per minute. The speed with normal field at 220 volts is also 500 revolutions per minute, so that by running at that voltage the field can again be weakened until a speed of 1,000 revolutions per minute is obtained. To illustrate these conditions the diagram Fig. 1

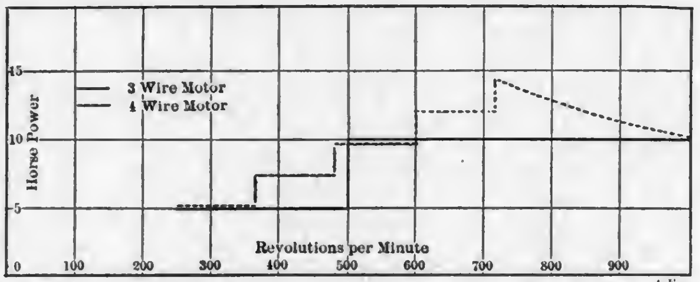


FIG. 1.—HORSE-POWER DIAGRAM FOR MOTORS ON THE 3 AND 4-WIRE SYSTEMS.

has been prepared, on which is shown in full lines the horse-power developed by such a motor at a varying number of revolutions. To make a comparison with the motor used on a four-wire system having the same range, 4 to 1, the same speeds and same minimum horse-power, the dotted lines on this diagram give the same information for that case, in which 40 per cent. variation in speed is obtained by field weakening. This does not represent the practice actually recommended by the manufacturers, but is what would be furnished to obtain the same range and number of revolutions. This diagram shows up several points. First, that the same general size of motor is required by both systems to do the same work, since evidently in this case each requires a motor that will develop 10 h.p. at 500 revolutions per minute, although the four-wire motor is capable of developing more at a greater speed, which the three-wire is not. It is fairly accurate to say, however, that the size of motor depends on the horse-power developed at a given speed, so that in this respect both systems are uniform. One point in this connection is worthy of notice. The three-wire motor develops 10 h.p. at 500 revolutions per minute. At that speed it will also develop 5 h.p. working on the lower voltage. Now, under the latter condition the current is the same, the speed the same, and the field is weakened 50 per cent. This is a condition under which the commutation would be equivalent to a motor working under 100 per cent. overload with normal field, if the motor were of ordinary construction. Your committee does not wish to go into the technical questions involved in this fact, but would call attention to it, as it is important. There are two factors affecting the horse-power that can be developed by any given motor, the heating and the commutation. The latter is the condition that on ordinary motors first gives trouble. If then it is intended to install a three-wire system with this method of speed control, special attention should be given to the capacity of the motor for commutation when working with weak fields, especially when overloaded under those conditions. It certainly requires a motor specially designed for this work, and it would not appear possible to adapt a standard motor to it.

Secondly, this diagram shows that while the three-wire system gives apparently equal results to the four-wire on tools requiring constant horse-power, it is inferior to it on tools in which the horse-power varies with the speed, such as, for instance, planers, slotters, shapers, etc. As these tools are not, however, in a majority, this feature is not perhaps of sufficient importance to seriously influence the question.

Again, the four-wire system affords, under the majority of conditions, greater power from the same sized motor than does the three-wire. If the motor is large enough under all conditions this is not important, but in a great many cases it will be found that unless motors are all installed that are of ample size, which means a relatively expensive plant, all the power that you can get out of a motor is a good thing to have, and this feature must be taken as an advantage in favor of the four-wire system. On the whole, this discussion is rather in favor of the latter, but there are some other points on the side of the three-wire that should not be overlooked. While requiring specially designed motors in place of the standard motors that are used on the four-wire system, it is possible to so arrange the generators that the plant is independent of the operation of a balancing set. This would be a very considerable advantage, as, while a balancing set gives no trouble whatever in operation, if any accident should happen to it all tools dependent on the intermediate voltages for their operation would be put out of service, and in a large plant it would appear desirable to install it in duplicate. The three-wire system also simplifies the lighting problem to a certain extent and affords what is practically a three-wire system for that purpose. Your committee in general feels that on this subject the time is not ripe for any

finite statement; the two systems referred to are both coming into use and their merits will be decided on the field of service. The chief features on one side and the other appear to be, the use of a special motor and one extra wire on the one side as against a standard motor and two extra wires on the other. There does not seem to be any great advantage in cost on one side or the other so far as investigation of the regular prices can determine where the cost of wiring is considered, and apart from this question, which is, perhaps, the most important one in the long run, the points deserving careful attention in considering the design of a plant would be the equal capacity of the motors offered for standing overloads so far as both heating and commutation are concerned, the speed of the motors at the maximum, which for equivalent cost it is desirable to keep equally low, the controller employed, the latter being quite an important detail of the apparatus, and the elimination of armature regulation beyond all limits referred to.

Beyond this discussion as to the system to be adopted for machine-shop driving which is decided by the above considerations, your committee does not feel that it desires to open the question of direct versus alternate current for the purposes in which speed control is not required, believing that since technical discussions on this subject before societies of electrical engineers do not appear to have ever been productive of any definite results, it is hardly worth while approaching from the standpoint of those who are not electricians, and would leave it to the question of convenience and local conditions by which it is so strongly affected after the driving of the locomotive machine shop has been disposed of.

STATISTICS AND DATA.

The efforts of the committee to compile complete and full data has been frustrated by the lack of exact information, although every possible effort to obtain same has been made, but it is hoped that before the paper goes into the Proceedings in permanent shape, any errors due to insufficient data will be corrected. Five or six shops are in process of erection at the present time, while three or four others are in a preliminary stage; consequently, none of these could be included in the table. (Not reproduced.—Ed.) It has been the endeavor of the committee to ascertain the "load factor" of the different schemes, but this could be obtained in a few cases only, owing to insufficient data. By load factor is meant the relation between the capacity of generators (after deducting the constant or fan loads, the average lighting load, etc.) and the variable loads, such as shop tools. The figures obtained seem to show that if 40 per cent. of the aggregate horse-power of the tools is taken and to this are added the constant and the average lighting load, we have a figure which will represent the generator capacity required without the necessity of taking into the account the cranes transfer or turn-tables. In this connection a spare unit should receive consideration.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.

STEAM AND AIR LINE CONNECTIONS.

COMMITTEE—H. F. BALL, T. W. DEMAREST, J. T. CHAMBERLAIN.

In considering the subject your committee broadened the scope of the work, including in its investigation the size of steam train pipe and other data which had a direct bearing on it. We were led to do this with the view of recommending a standard size of pipe as well as location of connections, all of which, if adopted by the association, would permit of changing the present equipment at one time and at least expense.

With one exception all of the roads represented in the replies to the circular of inquiry are using 1½ ins. diameter steam train pipe. This size of train pipe was adopted by many roads when steam for heating their passenger trains was first introduced and when trains consisted of six and eight cars. With the use of heavier locomotives the length of trains has been practically doubled, but with no corresponding increase or change in diameter of train pipe, with the result that on some roads, pressures for heating trains are being used up to 90 and 100 lbs., and with results not entirely satisfactory.

It is difficult to heat the rear cars of long trains; excessively long stops are required at division terminals to get steam through the train after changing engines, and with the high pressure used, the steam hose is subject to more rapid deterioration, resulting in delays on the road from burst steam hose, not to say anything about the increased cost of maintenance.

The time appeared opportune to consider the matter of enlarging the diameter of the steam train line, and with this in view a series of tests were conducted at Collinwood, Ohio, on a train of sixteen passenger coaches during the months of February and March.

The tests may properly be divided into four principal investigations, namely:

1. *The investigation of the steam hose coupling*, or a comparison between gasket openings of 1½, 1¼ and 1⅛-in. diameters with regard to their "steam obstructing" qualities in connection with 1½ and 2-in. diameter train pipes.
2. *The investigation of the train line*, or a comparison between a 2-in and 1½-in. train line with regard to their "steam obstructing" qualities, and their abilities to maintain a line pressure and provide steam to the radiators.
3. *The investigation of the admission valve*, or a comparison between a valve having a 1-in. diameter opening and one having a ¼-in. diameter opening, to determine their "steam obstructing" qualities (when open) on the train line, and their abilities to provide steam to the radiators.
4. *The investigation of steam pressures*, or a comparison between the effect of low pressure on the 2-in. line and high pressure on the 1½-in. line.

The apparatus for making these investigations consisted of the following: A train of sixteen 52-ft. passenger coaches, total length of train being about 900 ft., each car being equipped with both the 2-in. and 1½-in. train pipe.

The cars were provided with 1-in. steam inlet controlling valves, and for the ¼-in. diameter inlet opening, connection was broken and a copper gasket used with a ¼-in. diameter hole in it.

New steam gauges, carefully calibrated, and located about the center of each car, were provided.

Each car was equipped with three thermometers, one at each end and one in the center of the car, suspended from the ceiling. Thermometers were carefully calibrated.

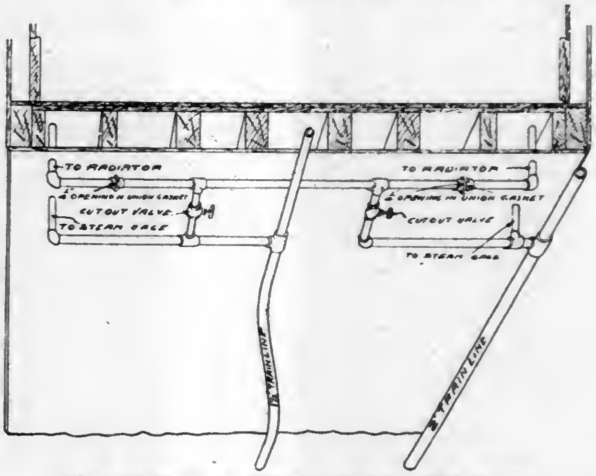
The train was placed on a special track near the power house of the Collinwood locomotive shop plant, in an exposed position, running east and west and having nothing on either side for its entire length to obstruct wind and weather.

Steam at 150 lbs. pressure was obtained through a 3-in. line from the power house, connection to the train being made exactly as with a locomotive, namely: a globe valve and 1-in. pipe to pressure regulator and 1½ or 2-in. pipe outlet to train line, with steam gauge. Between the regulating valve and end valve of train, connection was made with a ¾-in. air pipe with globe valve; through this line air at 90 lbs. pressure was obtained for blowing out steam pipe, to obtain constant temperatures at the termination of tests.

In the log of results, the tests are classified in alphabetical order and will be referred to in that manner. Many of the tests were conducted at night time, with a view of getting constant temperature conditions.

[Editor's Note.—The tests revealed a marked advantage in the use of 2-in. train line in all of the comparisons.]

In deciding upon localities of steam, air brake and signal connections it was found impracticable to establish fixed positions for these parts that could be adopted by all roads. Platform and draft gear designs not being alike on all roads renders the subject a very difficult one to treat. It was therefore deemed best to establish positions for steam heat, signal and air brake only, with relation to each other horizontally, and back from inside face of knuckle, to which all or nearly all can adhere. Then within certain limits, the air brake and steam heat pipes can be adjusted



ARRANGEMENT OF PIPING USED IN THE TESTS.

vertically or all the pipes can be shifted horizontally, providing their relative locations are maintained. This method provides sufficient flexibility to permit of the proposed locations being followed on any design of platform and when so arranged the connections will hang properly when coupled together.

RECOMMENDATIONS.

Your committee would recommend for adoption as recommended practice the following:

Two-inch steam train pipe; end train pipe valves; steam hose, 1⅝-in. inside diameter and of such length as to provide 31 ins. from face of coupling gasket to end of hose nipple; 1½-in. steam hose couplings with gaskets having 1½-in. diameter opening, gaskets to be so constructed that the normal diameter of opening will always be maintained; couplings not provided with gravity traps; inlet valves to have reduced openings which should be as small as possible and maintain the volume of steam required by the radiating pipes for the severest weather conditions, steam heat, air brake and signal connections to be located as shown on diagram; air brake and air signal hose to be 1-in. diameter and 22 ins. long.

COLLARLESS JOURNALS.

COMMITTEE—F. W. BRAZIER, E. D. NELSON, F. H. CLARK.

Your committee to consider and report upon the use of collarless journals prepared and submitted to the members a circular embodying questions in order to collect data on which to base its report to the convention:

Replies from thirty-one members, representing 640,608 freight and 14,629 passenger cars, show that 2 per cent. of the freight and 15 per cent. of the passenger equipment represented are equipped with collarless journals.

Thirty-one per cent. of the passenger and 2 per cent. of the freight cars represented in the replies were equipped with collarless journals, whereas 26 per cent. of the hot boxes on passenger and

1 per cent. of the hot boxes on freight cars were on the cars equipped with collarless journals.

All roads, but one, advise that they are using the same dust guards and lids, for both passenger and freight cars, with collar and collarless journals.

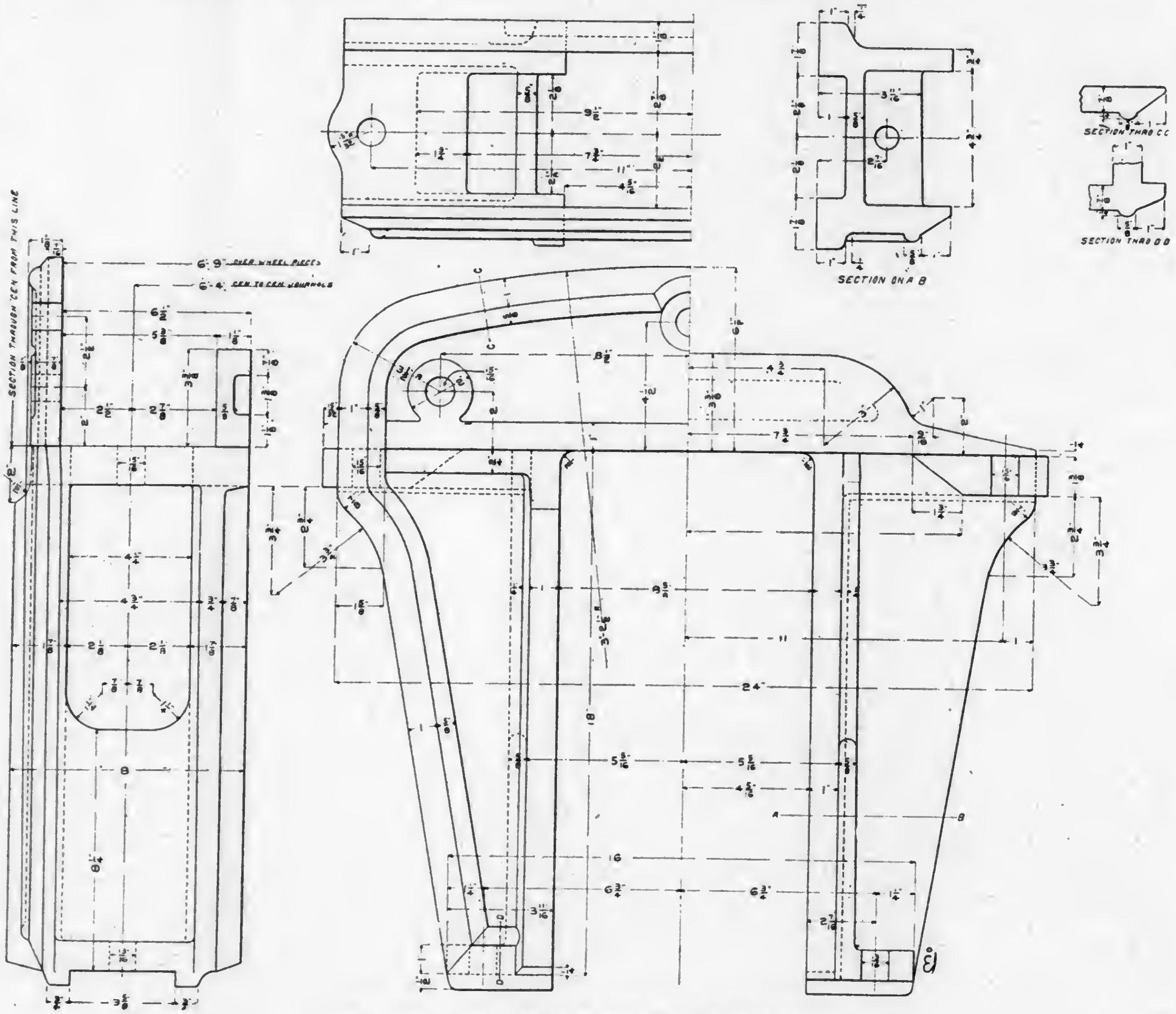
All roads state the same kind of bearing is used with both kinds of journals.

Replies cover 135 cases of broken journal under freight cars with collar journals, and eight under cars with collarless journals; no cases reported of broken journals under passenger cars during the period mentioned.

Of the members representing cars equipped with collarless journals, who made reply, nine advise it is more difficult to inspect the journal bearings on account of the journal bearing keys used with that, in most cases, the cause of hot boxes is the bad condition of the packing at the side and rear of the box, and that the only remedy is a systematic and efficient treatment of the packing to overcome the glazed or hardened condition resulting from too long contact with the journal, rather than by applying more oil.

In view of the foregoing facts your committee is of the opinion, based upon past experience, that the M. C. B., or collar type of journal, is almost a necessity to insure intelligent inspection and proper care of the packing in the journal boxes.

We also wish to call attention to the excessive end play with the collarless journal, allowing the brass to swing out over the end of the journal, thereby bringing the load farther from the fulcrum and causing a greater strain on the axle than is the case with the collar journal where the end play is limited.



PROPOSED STANDARD PEDESTAL FOR 5 BY 9-IN. JOURNALS.

the collarless journal, and five that there was no difficulty experienced.

Nine members reply that trucks keep square as well with the collarless journals as with the collar journal, and five members advise that they do not.

Your committee desires to call attention to the fact that the end of the journal bearings keys used with the collarless journal not only prevents proper inspection of the journal bearing and packing, but certainly interferes with the oilers giving to the packing, an important termini, the attention necessary to maintain the efficiency of the packing. This is more particularly true of the packing at the side and rear of the box, which can be readily appreciated by all who are familiar with the conditions surrounding this type of journal, due to the lack of space between the side of the journal box and the journal. This feature of maintaining the elasticity of the packing is becoming more essential with the increased loads and speed of trains of the present day, in order to overcome hot boxes, the danger of which is increased with the speed of the train.

It has been thoroughly demonstrated that the highest efficiency in lubrication is obtained, not by the simple process of adding more oil to the box, but by thoroughly maintaining the packing in a loose and elastic condition in order that the oil may be freely conveyed from the packing to the journal. It has also been shown

PROPOSED STANDARD PEDESTAL AND JOURNAL BOX FOR PASSENGER CARS FOR 5 BY 9-IN. JOURNALS.

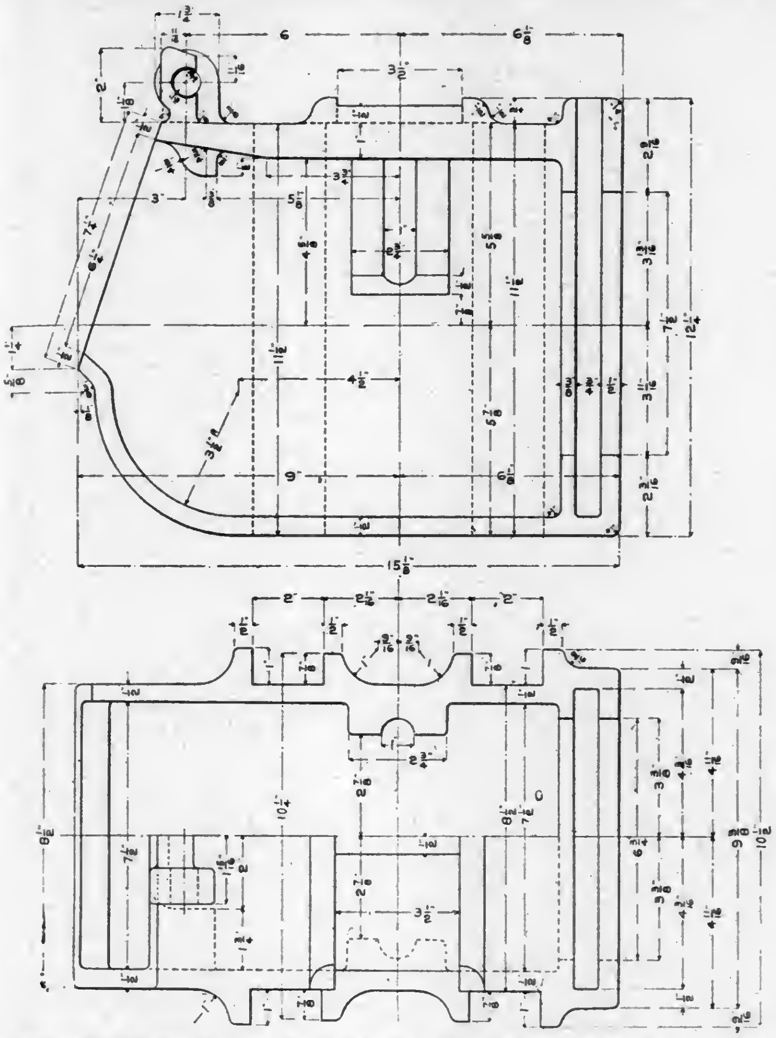
COMMITTEE—J. R. SLACK, T. B. PURVES, JR., WM. RENSHAW.

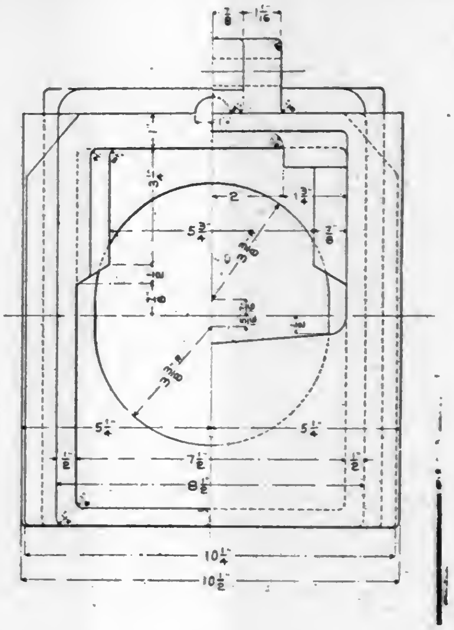
Your committee, appointed to submit a proposed design for Pedestal and Journal Box for Passenger Cars for 5 by 9-in. Journals, beg to submit designs as shown on the accompanying drawings.

LABORATORY TESTS OF BRAKE SHOES.

COMMITTEE—CHARLES COLLER, WM. GARSTANG, W. F. M. GOSS.

Since the presentation of the last formal report of your committee on Laboratory Tests of Brake Shoes, in June, 1901, four shoes have been tested by your committee; three of these were submitted on behalf of the Michigan Central Railway by Mr. E. D. Bronner, Superintendent of Motive Power, and one on behalf of the C., B. & Q. R. R. by Mr. F. H. Clark, Superintendent of Motive Power. The actual work of testing was performed by the authorities of the engineering laboratory of Purdue University, under the immediate direction of Edward Reynolds, Associate





PROPOSED STANDARD JOURNAL BOX FOR 5 BY 9-IN. JOURNALS.

Professor of Experimental Engineering, in accord with the standing arrangement existing between your committee and Purdue University. All results were duly reported to your committee, and thence transmitted to the parties interested. The characteristic mark borne by each shoe tested, the number assigned it in the laboratory, the date upon which the report was rendered, and the road submitting the shoe, are all shown by Table I.

TABLE I.

Mark on Shoe.	Lab. No.	Date on which Report was Rendered.	By Whom Submitted.
R. W. & F. Co.	79	Aug. 22, 1902....	Michigan Central Ry. Co., by E. D. Bronner, S. M. P.
R. W. & F. Co.	80	Aug. 22, 1902....	Michigan Central Ry. Co., by E. D. Bronner, S. M. P.
R. W. & F. Co.	81	Aug. 22, 1902....	Michigan Central Ry. Co., by E. D. Bronner, S. M. P.
Walsh........	114	May 2, 1903.....	C. B. & Q. R. R., by F. H. Clark, S. M. P.

Shoes Nos. 79, 80 and 81 were all of close-grained material, apparently iron, and except for the presence of blow holes, they were solid throughout their structure, no inserts being used. While they were to be regarded as hard shoes, no portion of them was chilled, and no difficulty was experienced in piercing them in any direction with a drill. The dimensions of the shoes were identical. When worn down to fit the wheel, their faces were 3⅜ by 13½; their length being measured on the arc. Upon the conclusion of the tests, the shoes were drilled and split lengthwise and photographs made both of the face and the fracture thus obtained. An examination of the fracture shows no perceptible difference in the structure of the several shoes. The fragments of the shoes are preserved, for the present, in the laboratory of Purdue University.

No. 114 was one of a lot of five sent to the laboratory, all of which were supposed to be alike. It is of soft cast iron having two pear-shaped inserts of hard metal, the outline of which appears upon its wearing face. All parts of the shoe, except the hard insert and the metal in its immediate vicinity were easily machined. The shoe was cast to fit a 36-in. wheel, and, therefore, required to be planed and ground down to an approximate fit to the 33-in. wheels used on the testing machine before any applications were made. Each insert is provided with a lug extending entirely through to the back of the shoe, and the body of the shoe is strengthened by two steel rods which extend lengthwise through it. The dimensions of the face of the shoe are 3½ ins. wide by 14 ins. long, as measured on the arc. The total area of contact is, therefore, 49 sq. ins., of which 9½ sq. ins., or about 20 per cent., is made up of the hard inserts, while the remaining 80 per cent. is of the soft cast iron forming the body of the shoe.

The routine of testing shoes was greatly simplified by the adoption, in June, 1901, of a standard specification which permits all tests upon a cast-iron wheel to be made from a speed of 40 miles an hour, and all tests upon a steel-tired wheel from a speed of 65 miles an hour. The process of testing under each condition specified has not been changed. Each shoe was brought into full bearing with the wheel by trial applications prior to the beginning of the formal tests. The usual precautions were taken to avoid overheating, both of the shoe and wheel, an air blast being used between every two or three applications.

The specifications of the Master Car Builders' Association provide that shoes when tested on the Master Car Builders' testing machine in effecting stops from a speed of 40 miles an hour shall develop a coefficient of friction which upon a chilled wheel shall not be less than

22 per cent. when the brake-shoe pressure is 2,808 lbs.
20 per cent. when the brake-shoe pressure is 4,152 lbs.
16 per cent. when the brake-shoe pressure is 6,840 lbs.

Also, that shoes when tested on a steel-tired wheel from a speed of 65 miles an hour shall develop a mean coefficient of friction which shall not be less than

16 per cent. when the brake-shoe pressure is 2,808 lbs.
14 per cent. when the brake-shoe pressure is 4,152 lbs.
12 per cent. when the brake-shoe pressure is 6,840 lbs.

The specifications also provide that the rise in the value of the coefficient of friction at the end of the stop will be within such limits that the value of the coefficient of friction for a point 15 ft. from the end of the stop will not exceed the mean coefficient of friction by more than 7 per cent.

A summary of the results obtained appears as Tables II. and III.

TABLE II.

COEFFICIENT OF FRICTION—PER CENT.

	Steel-Tired Wheel.					Chilled Wheel.				
Brake Shoe Pressure.	Value Specified.	Shoe Number. 79	80	81	114	Value Specified.	Shoe Number. 79	80	81	114
2808	16	14.4	15.9	15.5	15.1	22	20.	19.6	19.	25.
4152	14	12.7	12.9	13.6	14.1	20	16.3	18.1	17.4	25.4
6840	12	11.2	11.3	11.6	13.3	16	15.3	15.3	15.9	22.5

TABLE III.

RISE IN VALUE OF COEFFICIENT OF FRICTION, 15 FT. FROM END OF STOP.

	Steel-Tired Wheel.					Chilled Wheel.				
Brake Shoe Pressure.	Value Specified.	Shoe Number. 79	80	81	114	Value Specified.	Shoe Number. 79	80	81	114
2808	7	11.6	9.9	12.5	8.1	7	8.4	8.6	9.	5.3
4152	7	8.8	7.9	9.5	11.7	7	9.4	10.9	11.1	6.5
6840	7	6.2	7.1	6.9	7.4	7	6.4	8.6	5.9	3.7

The behavior of each shoe tested with reference to smoothness of action upon the wheel appeared normal in every way. There was no chattering, neither was there evidence of excessive wear upon the wheel. Shoes Nos. 79, 80 and 81 developed substantially the same coefficient of friction upon the chilled wheel, while upon the steel-tired wheel their performance was in the order in which they are numbered, No. 79 being the poorest, and No. 81 the best. The coefficient of friction developed by each of these shoes is below the requirements of the specifications, while the rise in the value of the coefficient at the end of the stop exceeds the limit allowed. No. 114 developed a coefficient of friction in excess of that specified in all but one case, and the rise in the value of the coefficient of friction at the end of the stop is well within the specified maximum when used upon the cast-iron wheel, but is in excess of the allowed limit when used upon the steel-tired wheel.

EXHIBITS AT THE CONVENTIONS.

Acme Supply Company, Chicago, Ill. Showing vestibule diaphragm.
Adams & Wastlake Company, Chicago. Adlake acetylene gas car-lighting system.
American Balance Valve Company, Jersey Shore, Pa. American balanced slide valves, American balanced piston valves, the J. T. Wilson high pressure balanced valve, the American Metallic piston rod and valve stem packing, the Nixon safety staybolt sleeve.
American Brake Shoe & Foundry Company, New York and Chicago. Railway brake shoes.
American Steam Gauge & Valve Company, Boston, Mass. Showing steam gauges and locomotive pop safety valves.
American Steel Foundries Company, New York and St. Louis.
Aurora Metal Company, Aurora, Ill. Showing the Lewis & Kunzer metallic piston packing.
Baltimore Railway Specialty Company, Baltimore, Md. The "Norwood" ball bearings, center and side bearings.
Besly & Co., Charles H., Chicago. Taps, parallel clamps and Gardner grinders.
Bordo, L. J., Philadelphia, Pa. Showing the Bordo blow-off valve and Bordo appliances.
Boston Belting Company, Boston, Mass. Showing an extensive exhibit of air brake hose and other material.
Brady Brass Company, New York, N. Y. Cyprus bronze for locomotive and journal bearings.
Buckeye Malleable Iron & Coupler Company, Columbus, Ohio. The Major automatic coupler.
Buffalo Forge Company, Buffalo, N. Y. Buffalo fans for mechanical induced draft, down draft forges, blowers and exhausters for shop equipment.
Coffin-Megeath Supply Company, Franklin, Pa. Showing car coupler.
Chicago Pneumatic Tool Company, Chicago, Ill. Full line of pneumatic hammers and drills and other pneumatic tools.
Commonwealth Steel Company, St. Louis, Mo. Models of trucks and separable bolsters.
Consolidated Railway Electric Lighting & Equipment Company, New York. Exhibiting on D. & H. tracks electric lighted Pullman car, "Elysian."
Crane Company, The, Chicago, Ill. The new Crane locomotive muffler pop safety valve, gun metal globe and angle valves and blow-off valves for high steam pressure.
Crocker-Wheeler Company, The, Ampere, N. J. Showing photographs of motor equipped machine tools and bulletins.
Damascus Brake Beam Company, St. Louis, Mo. Damascus brake beams.
Dayton Malleable Iron Company, Dayton, O. Dayton draft gear, Dayton patent car door fastener, lubricating center plate.
Detroit Lubricator Company, Detroit, Mich. Exhibit of lubricators.
Edwards Company, The O. M., Syracuse, N. Y. Showing fourteen designs of window models, recent improvements, six models of extension platform trapdoors for wide vestibules and open platforms for railroad coaches.
Franklin Manufacturing Company, The, Franklin, Pa. Showing asbestos dust guards, asbestos-magnesia molded boiler covering, asbestos train pipe covering.
Gold Car Heating & Lighting Company, New York, Chicago and London. Car heating apparatus, duplex coil system and straight steam operated under steam.
Gould Car Coupler Company, New York, N. Y. Improved M. C. B. journal boxes, improved malleable draft rigging for freight equipment with spring buffer blocks; improved M. C. B. coupler for 100,000-lb. car and improved locomotive tender coupler for heavy equipment; steel passenger platform with friction buffer and draft gear. Friction draft gear for freight for wood or steel sills. Improved roller side bearings for freight cars.
Hammett, H. G., Troy, N. Y. Richardson and Allen Richardson balanced slide valves, oil cups, "Sansom" bell ringer, link grinders and Prendergast metallic packing.
Handy Car Equipment Company, Chicago, Ill. Showing the Handy swinging pilot coupler, snow car and locomotive replacer.
Kennicott Water Softener Company, The, Chicago, Ill. Showing water softening apparatus.
Kindl Car Truck Company, Chicago, Ill. Showing Kindl car truck, Cloud car truck, roller side bearing, pedestal lateral motion.
Lodge & Shipley, Cincinnati, Ohio. Showing a 24-in. swing, 10-ft. bed, motor-driven engine lathe.
McConway & Torley Company, Pittsburg, Pa. Steel and malleable iron couplers for freight cars and tenders of the Kelso and Janney patterns.
McCord & Co., Chicago and New York. McCord journal box, McCord spring dampener, McKim gasket and Torrey anti-friction metal.
Manning, Maxwell & Moore, New York. Hancock inspirators, check valves, steam valves and strainers for locomotives.
Manufacturers' Railway Supply Company, Chicago, Ill. Showing interlocking car and driver brake shoes and interlocking driver brake head.
Merritt & Co., Philadelphia. Showing combination sheet steel ventilated, dustproof sheet steel and expanded metal lockers.
Michigan Lubricator Company, Detroit, Mich. Lubricator, oil cups and a new triple feed lubricator with new automatic safety device over sight feed glasses.
Midland Railway Supply Company, Chicago, Ill. Showing the Perry roller side bearings, blue prints and catalogues.
More-Jones Brass & Metal Company, St. Louis, Mo. Showing Arctic car brasses, Tiger bronze engine brasses, Hoo-Hoo and Rex babbitt metals.
National Malleable Castings Company, Cleveland, O. Showing the Tower locomotive coupler, the National journal box, National car door fastener.
National Car Coupler Company, Chicago, Ill. National steel platform and buffer for passenger cars, National freight car coupler, Hinson draft gear and the Hinson drawbar attachment.
Pittsburg Spring & Steel Company, Pittsburg, Pa. Showing locomotive and car springs.
Railway Appliances Company, The, Chicago, Ill. Showing the "Stanwood" car step, Ajax vestibule diaphragms, Fewing's car and engine replacer.
Railway Materials Company, The, Chicago, Ill. Showing Ferguson oil furnaces and Ferguson locomotive fire kindler.
Rand Drill Company, New York. Showing steam, electric and gas driven compressors; a complete line of Rand pneumatic tools.
Safety Car Heating & Lighting Company, New York, N. Y. Exhibiting car lighting and heating apparatus. The new features are fancy deck lamps, bracket lamps and a steam heating exhibit showing all the latest improvements in this line, and also buoy lantern.
Scarritt Furniture Company, St. Louis, Mo. Showing car chairs and seats.
Simplex Railway Appliance Company, Chicago. Simplex bolsters for 80,000-lb. capacity cars; also for 60,000-lb. cars; Susemihl frictionless side bearing and brake beams for all service.
Soule Dust Guard Company, Boston, Mass. Showing the Soule rawhide lined dust guard.
Standard Coupler Company, New York. Standard steel platforms, Sessions' standard friction draft gear, Standard couplers.
Standard Car Truck Company, Chicago, Ill. Showing Barber roller bearing truck models.
Symington Company, The T. H., Baltimore, Md. Showing journal boxes and dust guards.
Underwood, H. B., & Co., Philadelphia, Pa. Showing catalogue of special tools, boring bars and valve seat facers.
Washburn Coupler Company, Minneapolis, Minn. Showing freight couplers, flexible head passenger couplers and switch engine couplers.
Waycott Supply Company, St. Louis, Mo. Damascus brake beams.
Wellman-Seaver-Morgan Company, Cleveland, Ohio. Showing the Wellman-Street 100,000-lb. capacity steel hopper car, the Wellman-Street cast steel bolster, the Street tandem draft gear, the Street twin draft gear, the Street journal box.
Whall, C. H., & Co., Boston, Mass. Showing metallic window casings, car ventilator and samples of fiber.
Westinghouse Air Brake Company, The, Pittsburg, Pa.; The American Brake Company, St. Louis, Mo.; Westinghouse Automatic Air & Steam Coupler Company, St. Louis, Mo.

The Buffalo Steam Pump Company, whose works are at North Tonawanda, has been purchased by Messrs. William F. and Henry W. Wendt, who are also owners of the Buffalo Forge Company and the George L. Squier Manufacturing Company. The North Tonawanda works of the steam pump company are to be continued as heretofore, and the main offices will be in Buffalo.

We understand the records in the clerk's office of the United States Circuit Court for the Northern District of New York disclose the fact that a suit has recently been instituted in that court by the Safety Car Heating & Lighting Company against the Consolidated Car Heating Company for alleged infringement of its patents in connection with car heating devices. We presume this is the outcome of the claims made by the Safety Car Heating & Lighting Company to which reference was recently made in our columns. The suit is evidently one of considerable importance as the bill was filed by Betts, Betts, Sheffield & Betts, of New York City, with Frederic H. Betts, Samuel R. Betts, Edward P. Wetmore and Randolph Parmly as counsel.

The Norwood side bearings and center plates have been improved in important respects since last year. The general construction is not changed, but provision is made to insert the ball races of the side bearings at the ends of the castings with a dovetail fit, preventing them from raising. The ball race casting is now provided with a motion of one-half inch endwise of the bolster, and adequately secured from further motion by a guide casting secured to the bolster. This permits the side bearings to adjust themselves to an old center plate. The ball bearing center plate is now milled to admit the ball race, the work being done accurately and the parts interchange. These are a few of the improvements seen in the exhibit at the Saratoga conventions of the Baltimore Railway Specialty Co., Calvert Building, Baltimore.

INTERLOCKING BRAKE SHOES AND HEAD FOR DRIVER BRAKES.

Brake shoes are frequently thrown away when but little worn, due to imperfect bearings or uneven wear, which results from defects in the brake gear. When fairly well worn down they are scrapped with a large loss of material which would be overcome by construction which would permit the shoe to be entirely worn through. This the Manufacturers' Railway Supply Company aim to provide in their new interlocking brake shoe, and also to guard against the breakage of shoes by parting them in the center in such a way as to permit of more perfect fitting to the wheel. Many shoes break before they are near the end of a fair mileage because of weakening through wear.

The construction of the shoe and the head required to receive them is clearly indicated in the accompanying engravings. In spite of the expense of the new head, it is stated that the saving

BACK OF BOTH PLAIN AND POCKET FACED SHOE.

POCKET FACED SHOE.

PLAIN FACED SHOE.

SECTIONAL VIEW OF HEAD.

PARTIALLY WORN SHOE.

HOLDING LUG LOCK.

in the wear of the first set of shoes produces a net gain, because driver brake shoes are usually scrapped at one-half their original weight, or, say, between 15 and 30 lbs., according to their size. An average of 30 lbs. would fairly represent usual conditions. With the interlocking shoe this would be entirely worn out, and the cost of the new head will be balanced by the additional wear of the shoes, while costing much less per pound than the material put into the shoes.

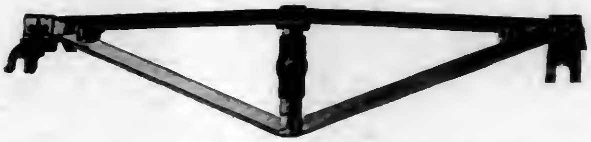
The interlocking shoes for car wheels have already been illustrated in this journal, and it is fair to expect equally satisfactory results in the driver brake shoes. The engraving illustrates the reinforcement of the worn shoes by the old shoes and the head itself. This new construction of brake shoes is entitled to careful investigation. The address of the Manufacturers' Railway Supply Company is Fisher Building, Chicago.

The More-Jones Brass & Metal Co., of St. Louis, distributed graceful souvenirs to the ladies of the Master Mechanics' and Master Car Builders' conventions, in the form of beautiful roses tied with white satin ribbons. The company was represented by Mr. D. A. Campbell.

THE WAYCOTT BRAKEBEAM.

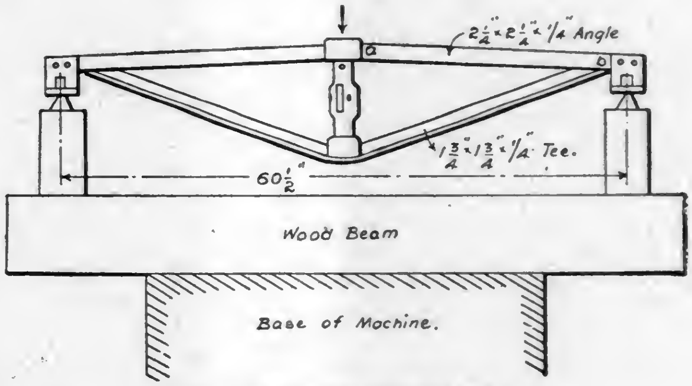
The great success which has been attained by the Damascus brakebeam, which was introduced about eighteen months ago by the Damascus Brakebeam Company, of St. Louis, has induced the same manufacturers to bring out a new beam, which will be known as the "Waycott." The Damascus is a solid beam, and since its introduction has met with such favor as to have caused the sale of over 150,000 beams, which are now in use on a large number of railroads in all parts of the United States.

The Waycott beam is of different construction, as shown, being



a truss beam made of commercial shapes put together in the simplest possible form. The compression member is a 2¼ x 2¼ x ¼-in. angle, and the tension member a 1¾ x 1¾ x ¼-inch tee. The two members are united by heads and fulcrum pieces of malleable iron, the frame being riveted through both members. The hanger eyebolts are attached to clamps which embrace both parts of the beam. The distribution of the metal is admirably arranged so as to give the required strength with a minimum of weight.

A test of this beam was recently made by the engineering laboratory of Purdue University with very satisfactory results. The

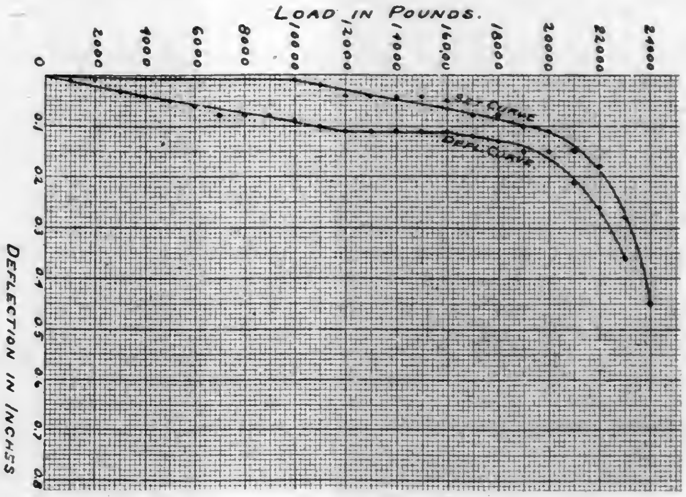


BRAKE BEAM ARRANGED FOR TEST.

tests were made upon two beams, and the results are given in condensed form as follows:

	No. 1.	No. 2
Weight of beams in pounds	62.5	62¾
Load in pounds at elastic limit	20,000	20,000
Deflection in inches at elastic limit	.15	.28
Set in inches at elastic limit	.11	.17
Load in pounds at point of failure	24,000	23,000

In this test the brakebeam was supported on knife edges resting on steel plates, which in turn rested on 15 x 20-in. wood beam supported on the base of a 300,000-lb. Riehle testing machine. The knife edges were placed 60½ ins. apart, being the distance



required by M. C. B. standard from center to center of brakeshoes. Before applying any loads for record, a load of 7,000 lbs. was applied and then removed, this being done in order to take up any free

movement of the parts that might exist in the construction. The load under the test was applied in increments of 1,000 lbs. and the corresponding deflection read with each application. The running log of the test on beam No. 1, is presented below, the set and deflection curves obtained from these records being presented in the above diagram.

RUNNING LOG.

Flexure Test of Damascus Truss Brakebeam.

Load in Pounds.	Deflection in Inches.	Set in Inches.	Load in Pounds.	Deflection in Inches.	Set in Inches.
0	0	0	13,000	0.11	0.04
1,000	0.01	0	14,000	0.11	0.04
2,000	0.01	0	15,000	0.11	0.04
3,000	0.03	0	16,000	0.11	0.05
4,000	0.04	0	17,000	0.12	0.08
5,000	0.05	0	18,000	0.13	0.08
6,000	0.06	0	19,000	0.15	0.10
7,000	0.08	0	20,000	0.15	0.11
8,000	0.08	0	21,000	0.21	0.15
9,000	0.08	0	22,000	0.26	0.18
10,000	0.09	0.01	23,000	0.36	0.28
11,000	0.10	0.02	24,000	*	0.45
12,000	0.11	0.04			

*Compression member buckled at (a) and (b). See diagram of beam as arranged upon the blocks for testing.)

The Consolidated Railway Electric Lighting & Equipment Co., 100 Broadway, always make an impressive exhibit at the mechanical association conventions. This year they had the private Pullman car "Elysian" at Saratoga. This was the car used by President Roosevelt in his recent transcontinental trip and is altogether the finest car turned out at Pullman. It is equipped with the apparatus of this company and was seen in operation in the trips from New York to Saratoga and return by a large number of guests of the company who were invited to enjoy its genial hospitality and inspect the operation of the electric lighting apparatus. While passengers in the other cars of the train were sweltering during a very hot trip the party in this car was made perfectly comfortable by the electric fans driven from the lighting circuits. This company now has 900 equipments in service, 130 of which are on one railroad, the Santa Fe.

A number of improvements in the apparatus manufactured by the American Steam Gauge & Valve Mfg. Company, Jamaica Plain, Boston, Mass., were exhibited at the recent conventions at Saratoga. The exhibit was arranged to show at a glance the wide range of apparatus covered and among the specialties which stood out prominently were the following. A new American Thompson indicator with a convenient detent attachment which will be appreciated by all who use these instruments, another indicator of the same style, with a reducing motion attachment which takes the place of large, awkward and unsatisfactory levers and pantagraphs, new locomotive pops, in which all adjustments are made at the top, heavy automatic high pressure water gauges, duplex air brake gauges with a solid socket for the springs, locomotive gauges and automatic recording gauges. The exhibit also included test pumps, muffled pops and many other specialties made by this concern, and all arranged in a very attractive way.

The Safety Car Heating & Lighting Company had, as usual, a most attractive exhibit at the Master Mechanics' and Master Car Builders' conventions. It was in the tasteful elegant style which always characterizes the exhibits of this company, and conveyed an impression of combined beauty and utility. In addition to the exhibit of the Pintsch light in the hotel corridor this company had a room fitted up with steam heating apparatus illustrating their latest improvements in facilities for heating cars. They showed their new end valves as applied to a model of a car platform, also the new hose couplings with 1½ inch openings and improved gasket fastenings. Among the other improvements was a new jacket heater in which the steam enters a central tube and doubles back in a surrounding tube, both steam tubes being enclosed in the large outer jacket tube. The results of a test showing the advantages of the 1½ inch openings in hose couplings were exhibited in blue print form. This company is busy with improvements in car heating and those who have not recently made a study of their apparatus will find the subject interesting.

NEW QUARTERS FOR THE BRODERICK & BASCOM ROPE CO.—WIRE ROPE AND TACKLE BLOCK STORAGE.

The Broderick & Bascom Rope Co., of St. Louis, have recently moved into their commodious new quarters at Nos. 805, 807 and 809 North Main street. The illustration presented herewith represents the second story floor of their building at No. 809. On this floor, as shown in the illustration, is carried an immense stock of tackle blocks and wire rope. We feel certain that an array of blocks and reels of wire rope like this, on a single floor, will present an impression of the magnitude of the business done in this line by this well-known firm. There is probably no wire rope concern in the United States that carries, under one roof, a larger assortment of wire rope, blocks and tackle, manila rope and cordage of every description.

The Broderick & Bascom Co. was established in 1875, and incorporated in 1882. They are successors to the old St. Louis Wire Rope Works, both Mr. John J. Broderick, the president, and Jos. D. Bascom, the secretary and treasurer, having had long experience in the wire rope business. When first starting to manufacture wire rope it was made by hand, instead of by machinery. Their former superintendent, Mr. Wm. Mentz, has been a manufacturer of wire rope from 1840, having made all of the wire ropes that were used by Jas. B. Eads in constructing the renowned Eads Bridge.

The wire ropes are composed of a hempen cord, around which are laid six wire strands, of seven, twelve or nineteen wires, thus forming ropes of 42, 72 or 114 wires. The ropes of seven wires to the strand are most commonly used for standing ropes, guy, ship rigging, transmission of power, mine haulage and for contractors' purposes. These ropes are as flexible as hemp ropes of equal strength, and though weighing less, are far more efficient and durable. A strain of one-seventh to one-fifth of the breaking strain may be taken as a safe working load. In the special power wire rope, made by this company, every wire is thoroughly tested for tensile strength, torsion, elongation and elastic limit, and these tests are registered for reference. The company is prepared to furnish rope from stock one-sixteenth of an inch up to two inches in diameter, and from 5,000 to 20,000 ft. long.

The Broderick & Bascom Rope Co. have a large mailing list, for sending out monthly quotations, and will be glad to add the names of any master mechanic, master car builder or purchasing agent to their list and invite correspondence.

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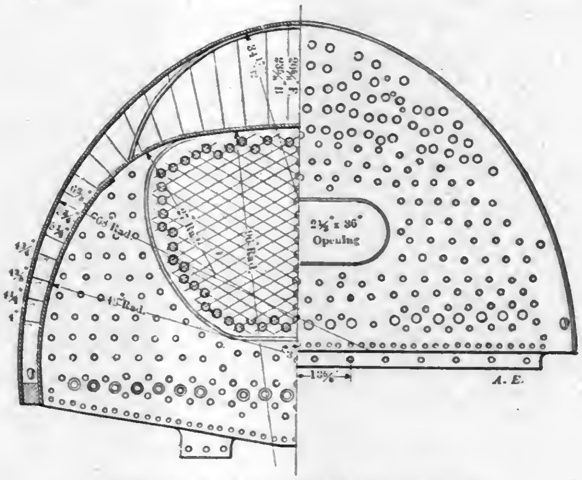

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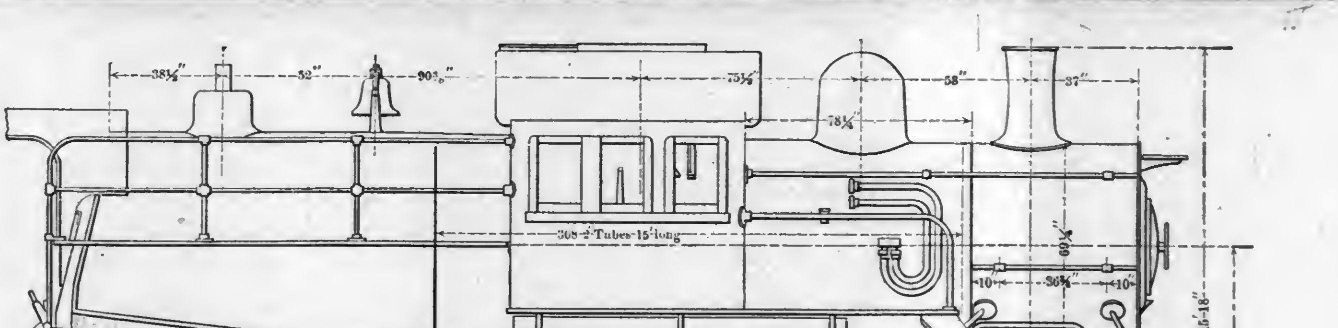

CULM-BURNING PASSENGER LOCOMOTIVE.—DELAWARE & HUDSON COMPANY.
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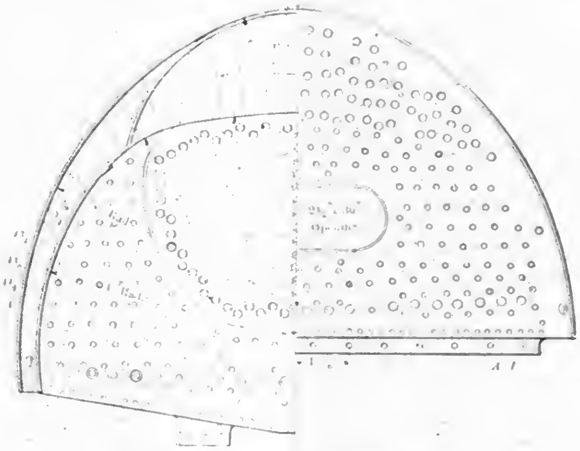

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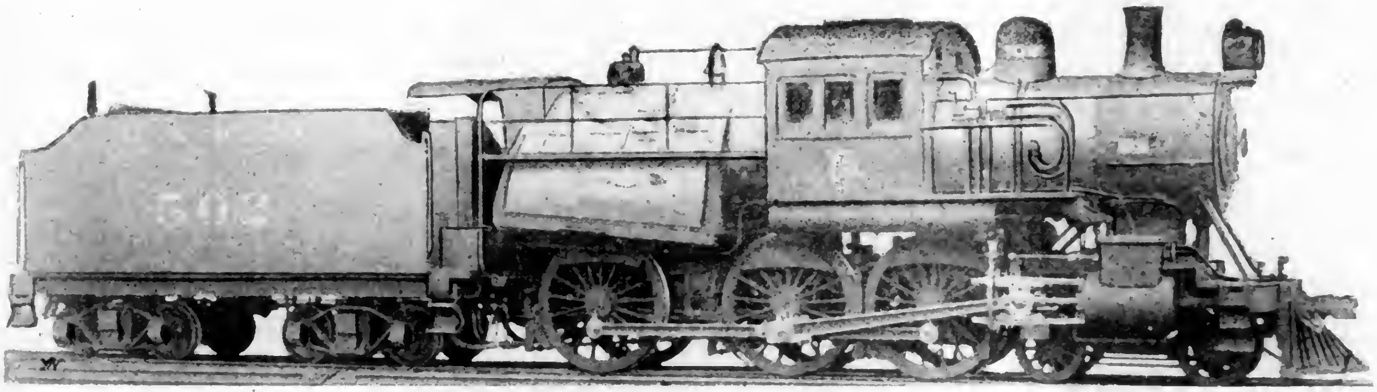
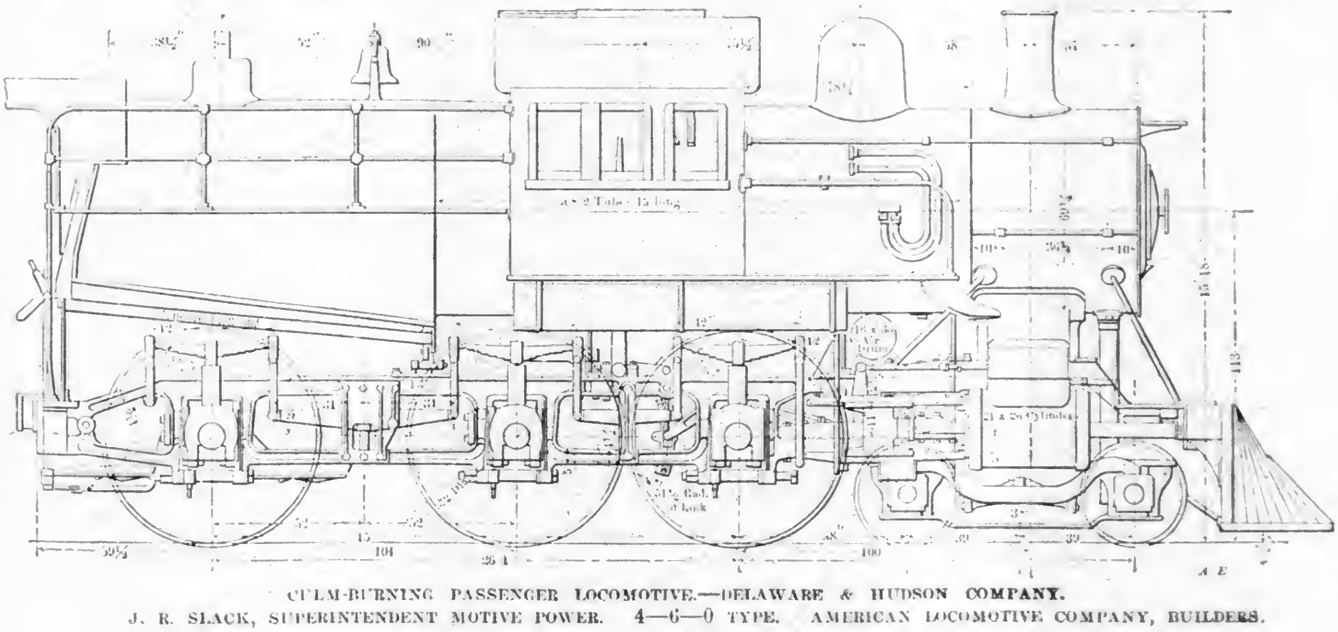




CULM-BURNING PASSENGER LOCOMOTIVE.—DELAWARE & HUDSON COMPANY.

J. R. SLACK, SUPERINTENDENT MOTIVE POWER. 4—6—0 TYPE. AMERICAN LOCOMOTIVE COMPANY, BUILDERS.

wide experience and close study of the failures of cast steel frames as ordinarily made. These frames have curves instead of sharp corners, and large fillets in all angles. These frames are strongly braced across the engine at the driving boxes and are made in I sections. Another feature of this engine is the application of the new Wilson high-pressure balanced valve. This engine has 9 x 13-in. driving journals.

The following ratios and table of dimensions will be found interesting:

Ratios.

Heating surface to cylinder volume	= 256.2
Tractive weight to heating surface	= 49.4
Tractive weight to tractive effort	= 4.85
Tractive effort to heating surface	= 10.17
Tractive eff. × diam. of drivers to heating surface	= 732.4
Heating surface to tractive effort	= 9.8 %
Total weight to heating surface	= 65.7

CULM-BURNING PASSSENGER LOCOMOTIVE.

4—6—0 TYPE. DELAWARE & HUDSON COMPANY.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Fine anthracite coal
Weight in working order	175,000 lbs.
Weight on drivers	131,500 lbs.
Weight engine and tender in working order	292,250 lbs.
Wheel base, driving	16 ft.
Wheel base, rigid	16 ft.
Wheel base, total	26 ft. 4 ins.
Wheel base, total, engine and tender	53 ft. 7½ ins.

Cylinders.

Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5 ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast-iron rings
Kind of piston-rod packing	U. S. multiangular
Size of steam ports	18 in. x 1⅝ ins.
Size of exhaust ports	18 x 3 ins.
Size of bridges	1⅜ ins.

Valves.

Kind of slide valves	Wilson's American high-pressure
Greatest travel of slide valves	5½ ins.
Outside lap of slide valves	1 in.
Inside lap of slide valves	0 in.
Lead of valves in full gear	1-16 in.
Kind of valve-stem packing	U. S. multiangular

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	72 ins.
Material of driving wheel, centers	Cast steel
Thickness of Tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9 ins. diameter x 13 ins.
Diameter and length of main crank-pin journals, (Main side 7½ x 4¼ ins.)	6½ ins. diameter x 6½ ins.
Diameter and length of side-rod crank-pin journals	5 ins. diameter x 4¾ ins.
Engine truck, kind	4-wheel, swing bolster
Engine truck, journals	6½ ins. diameter x 12 ins.
Diameter of engine-truck wheels	33 ins.

Boiler.

Style	Culm burner
Outside diameter of first ring	66¼ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox:	½ in., ⅝ in., 21-32 in. and ¾ in.
Horizontal seams	Butt joint sextuple riveted
Circumferential seams	Double riveted
Firebox, length	119⅞ ins.
Firebox, width	102 ins.
Firebox, depth	Front, 64 ins.; back, 42 ins.
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 3½ ins.; sides, 3 ins.; back, 3½ ins.
Firebox, crown staying	Radial
Firebox, staybolts	Ulster special, 1 in. diameter
Tubes, number	308
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft.
Heating surface, tubes	2,405.5 sq. ft.
Heating surface, water tubes	78.54 sq. ft.
Heating surface, firebox	179.68 sq. ft.
Heating surface, total	2,663.72 sq. ft.
Grate surface	84.85 sq. ft.
Grate style	Water grate
Exhaust pipes	Double
Exhaust nozzles	3¼ ins., 3⅜ ins., 3½ ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	15 ft. 1⅛ ins.

Tender

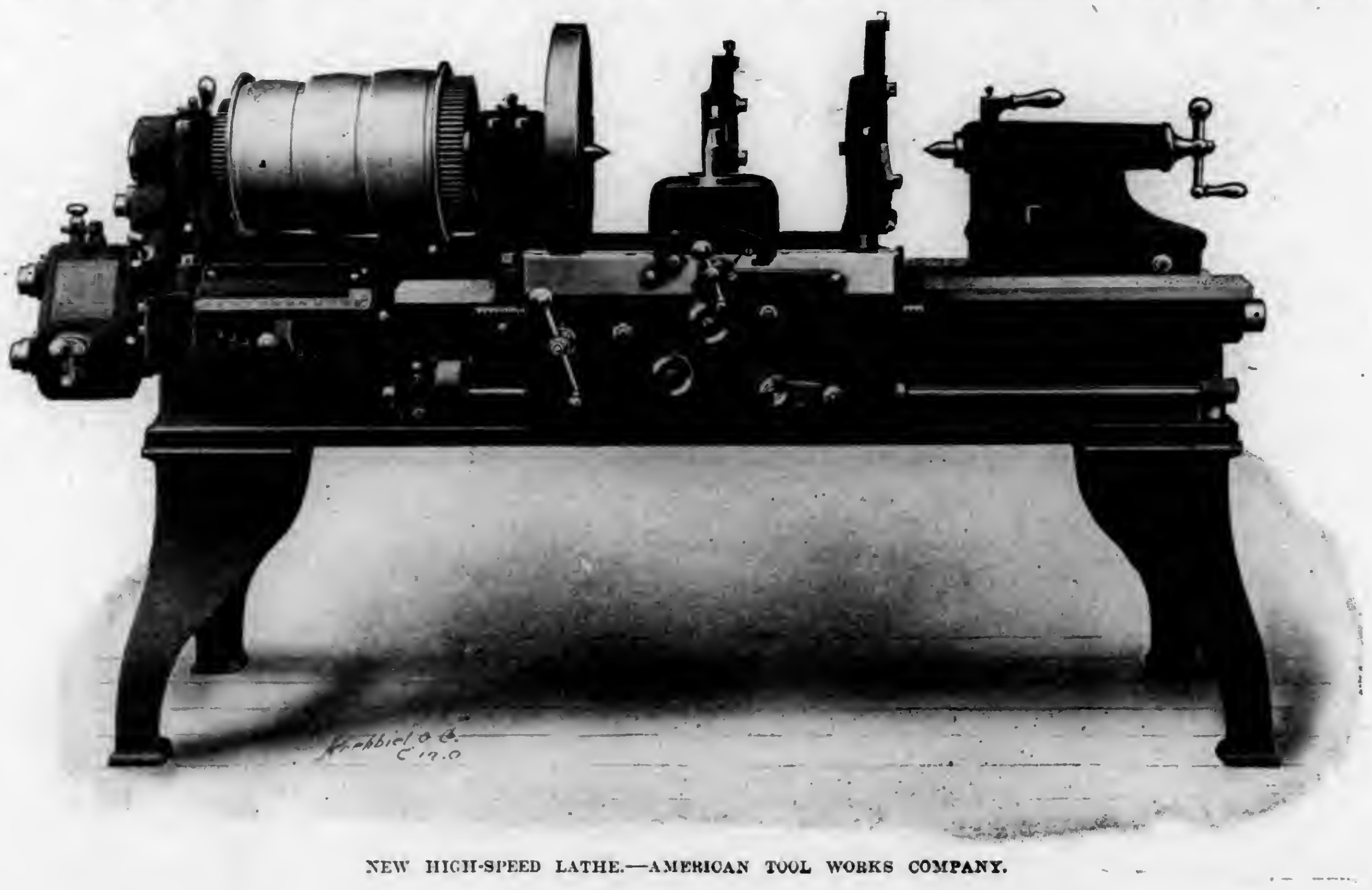
Style	8-wheel, water bottom
Weight, empty	47,100 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	18 ft. 5 ins.
Tender frame	10-in. steel channels
Water capacity	6,500 U. S. gals.
Coal capacity	8 tons

A NEW EXTRA-HEAVY HIGH-SPEED LATHE.

THE AMERICAN TOOL WORKS COMPANY.

The use of the new high-duty tool steels for rapid machining processes has been very effective in exposing the limitations of the very best modern machine tools and in suggesting advantageous improvements in design. The improvements in the heavy and rapid machining processes thus made possible have been readily appreciated by the American Tool Works Company, Cincinnati, Ohio, who have been foremost in adapting their designs to conform to the new practice.

In the above engraving is illustrated an interesting new type of lathe which has recently been placed upon the market



NEW HIGH-SPEED LATHE.—AMERICAN TOOL WORKS COMPANY.

by the American Tool Works Company, which they have termed the "American" high-speed lathe. The principal feature of this lathe is that it has been designed particularly for high-speed cutting on work from 1 to 4 ins. in diameter. It has been designed throughout to meet the special requirements of modern high-speed tool steels; it has been the aim to place the limit of work at the cutting tool rather than at the belt, and with this point in view the apron, carriage and bed and other details have been given exceptional strength and the headstock has been endowed with enormous belt power—such that the contact of the belt when on the smallest step of the cone is greater than that on the ordinary 36-in. lathe.

The belt cone is so designed that a 4-in. double belt can be shifted to any of the three steps with the greatest facility. There are twelve changes of speed in the drive, so graded that a cutting speed of 160 ft. per minute can be maintained on work ranging from 1 in. to 4 ins. diameter. The bearings, owing to the very high spindle speeds, are of unusual size, made of phosphor bronze, and are self-oiling.

This lathe is equipped with their new rapid change-gear feeding mechanism, which was described **on page 41** of our April, 1903, issue. This gear mechanism is a positive drive in either direction and is capable of feeding up to the limit of the belt power. Through the four-speed box at the end of the bed operating in conjunction with the cone of eleven gears mounted on the inside of the bed, a range of 44 changes for feeding and screw cutting is easily available, while the machine is in operation and without the removal of a single gear.

The bed is of a patent drop V pattern, which gives 2 ins. additional swing without raising the head and allows placing a great deal of extra metal in the bridge of the carriage. The lead screw is placed on the inside of the bed, bringing the pull directly under the cutting tool, thus centralizing the strain and obviating all that tendency to twist, so common in lathes with the screw on the outside.

An elaborate series of tests was recently performed on this machine, which we are enabled to present. The cuts were taken with a well-known brand of high-speed tool steel, on bars of commercial machinery steel; in each experiment the tool was tested to the breaking-down point. The actual results derived are presented below, showing the cutting speed in feet per minute at the moment of the breaking down of the tool:

RESULTS OF THE TESTS.

Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.	Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.	Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.
1..	1-64	1-16	326	10..	1-64	3-32	326	19..	1-64	1/8	336
2..	1-64	1-16	425	11..	1-64	3-32	368	20..	1-64	1/8	326
3..	1-64	1-16	339	12..	1-64	3-32	332	21..	1-64	1/8	310
4..	1-32	1-16	320	13..	1-32	3-32	230	22..	1-32	1/8	250
5..	1-32	1-16	360	14..	1-32	3-32	268	23	1-32	1/8	260
6..	1-32	1-16	354	15..	1-32	3-32	285	24..	1-32	1/8	267
7..	3-64	1-16	381	16..	3-64	3-32	262	25..	3-64	1/8	231
8..	3-64	1-16	327	17..	3-64	3-32	209	26..	3-64	1/8	220
9..	3-64	1-16	330	18..	3-64	3-32..	227	27..	3-64	1/8	240

It may be seen from the above that a very high rate of cutting speed was attained throughout, in some instances being truly remarkable, considering the fact that it was on a roughing cut. The lathe withstood this exceptionally heavy duty without a sign of distress. This goes to prove the trend of modern possibilities in rapid work production.

A 30-TON FLAT CAR 61 FEET LONG.

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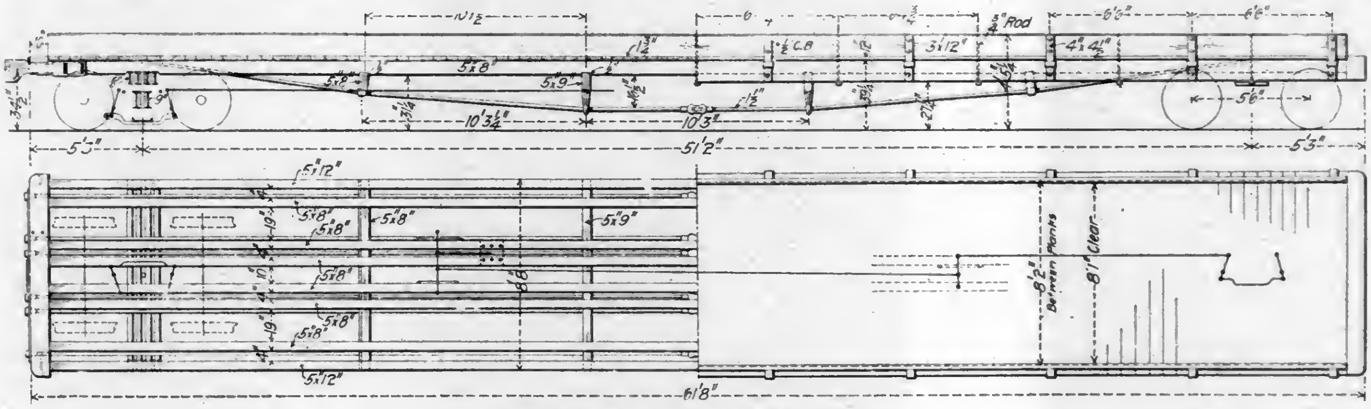

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wide experience and close study of the failures of cast steel frames as ordinarily made. These frames have curves instead of sharp corners, and large fillets in all angles. These frames are strongly braced across the engine at the driving boxes and are made in 4 sections. Another feature of this engine is the application of the new Wilson high-pressure balanced valve. This engine has 9 x 13 in. driving journals.

The following ratios and table of dimensions will be found interesting.

Ratios.

Heating surface to cylinder volume	= 256.2
Tractive weight to heating surface	= 49.4
Tractive weight to tractive effort	= 4.85
Tractive effort to heating surface	= 10.17
Tractive effort x diam. drivers to heating surface	= 732.4
Heating surface, firebox, to total heating surface	= 9.8 %
Total weight to heating surface	= 65.7

CULM-BURNING PASSENGER LOCOMOTIVE.

DELAWARE & HUDSON COMPANY.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Fine anthracite coal
Weight in working order	175,000 lbs.
Weight on drivers	131,500 lbs.
Weight engine and tender in working order	292,250 lbs.
Wheel base, driving	16 ft.
Wheel base, rigid	16 ft.
Wheel base, total	26 ft. 4 ins.
Wheel base, total engine and tender	53 ft. 7½ ins.

Cylinder.

Diameter of cylinder	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5 ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast-iron rings
Kind of piston-rod packing	U. S. multiangular
Size of steam ports	18 in. x 1⅜ ins.
Size of exhaust ports	18 x 3 ins.
Size of bridges	1⅜ ins.

Valves.

Kind of slide valves	Wilson's American high-pressure
Greatest travel of slide valves	5½ ins.
Outside lap of slide valves	1 in.
Inside lap of slide valves	0 in.
Lead of valves in full gear	1-16 in.
Kind of valve stem packing	U. S. multiangular

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	72 ins.
Material of driving wheel, centers	Cast steel
Thickness of Tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9 ins. diameter x 13 ins.
Diameter and length of main crank-pin journals	(Main side 7½ x 14 ins.) 6½ ins. diameter x 6½ ins.
Diameter and length of side-rod crank-pin journals	5 ins. diameter x 4¾ ins.
Engine truck, kind	4-wheel, swing bolster
Engine truck, journals	6½ ins. diameter x 12 ins.
Diameter of engine-truck wheels	33 ins.

Boiler.

Style	Culm burner
Outside diameter of first ring	66¼ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	½ in., ⅝ in., 21-32 in. and ¾ in.
Horizontal seams	Butt joint sextuple riveted
Circumferential seams	Double riveted
Firebox, length	119⅞ ins.
Firebox, width	102 ins.
Firebox, depth	Front, 61 ins.; back, 42 ins.
Firebox plates, thickness	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 3½ ins.; sides, 3 ins.; back, 3½ ins.
Firebox, crown staying	Radial
Firebox, staybolts	Ulster special, 1 in. diameter
Tubes, number	308
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft.
Heating surface, tubes	2,405.5 sq. ft.
Heating surface, water tubes	78.54 sq. ft.
Heating surface, firebox	179.68 sq. ft.
Heating surface, total	2,663.72 sq. ft.
Grate surface	81.85 sq. ft.
Grate style	Water grate
Exhaust pipes	Double
Exhaust nozzles	3¼ ins., 3⅜ ins., 3½ ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	15 ft. 1¼ ins.

Tender.

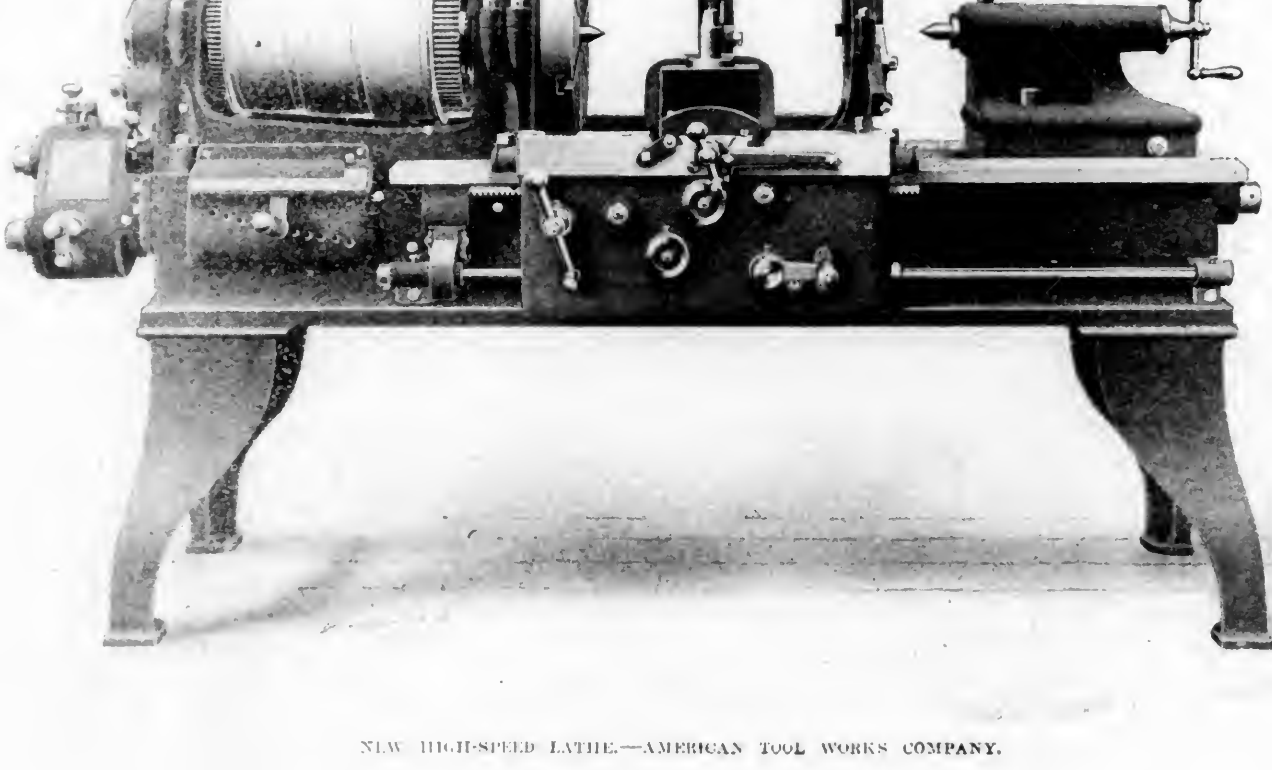
Style	8-wheel, water bottom
Weight, empty	47,100 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	18 ft. 5 ins.
Tender frame	10-in. steel channels
Water capacity	6,500 U. S. gals.
Coal capacity	8 tons

A NEW EXTRA-HEAVY HIGH-SPEED LATHE.

THE AMERICAN TOOL WORKS COMPANY.

The use of the new high-duty tool steels for rapid machining processes has been very effective in exposing the limitations of the very best modern machine tools and in suggesting advantageous improvements in design. The improvements in the heavy and rapid machining processes thus made possible have been readily appreciated by the American Tool Works Company, Cincinnati, Ohio, who have been foremost in adapting their designs to conform to the new practice.

In the above engraving is illustrated an interesting new type of lathe which has recently been placed upon the market



NEW HIGH-SPEED LATHE.—AMERICAN TOOL WORKS COMPANY.

by the American Tool Works Company, which they have termed the "American" high-speed lathe. The principal feature of this lathe is that it has been designed particularly for high-speed cutting on work from 1 to 4 ins. in diameter. It has been designed throughout to meet the special requirements of modern high-speed tool steels; it has been the aim to place the limit of work at the cutting tool rather than at the belt, and with this point in view the apron, carriage and bed and other details have been given exceptional strength and the headstock has been endowed with enormous belt power—such that the contact of the belt when on the smallest step of the cone is greater than that on the ordinary 36-in. lathe.

The belt cone is so designed that a 4-in. double belt can be shifted to any of the three steps with the greatest facility. There are twelve changes of speed in the drive, so graded that a cutting speed of 160 ft. per minute can be maintained on work ranging from 1 in. to 4 ins. diameter. The bearings, owing to the very high spindle speeds, are of unusual size, made of phosphor bronze, and are self-oiling.

This lathe is equipped with their new rapid change-gear feeding mechanism, which was described on page 48 of our April, 1903, issue. This gear mechanism is a positive drive in either direction and is capable of feeding up to the limit of the belt power. Through the four-speed box at the end of the bed operating in conjunction with the cone of eleven gears mounted on the inside of the bed, a range of 44 changes for feeding and screw cutting is easily available, while the machine is in operation and without the removal of a single gear.

The bed is of a patent drop V pattern, which gives 2 ins. additional swing without raising the head and allows placing a great deal of extra metal in the bridge of the carriage. The lead screw is placed on the inside of the bed, bringing the pull directly under the cutting tool, thus centralizing the strain and obviating all that tendency to twist, so common in lathes with the screw on the outside.

An elaborate series of tests was recently performed on this machine, which we are enabled to present. The cuts were taken with a well-known brand of high-speed tool steel, on bars of commercial machinery steel; in each experiment the tool was tested to the breaking-down point. The actual results derived are presented below, showing the cutting speed in feet per minute at the moment of the breaking down of the tool:

RESULTS OF THE TESTS.

Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.	Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.	Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.
1	1-64	1-16	326	10	1-64	3-32	326	19	1-64	⅛	336
2	1-64	1-16	425	11	1-64	3-32	368	20	1-64	⅛	326
3	1-64	1-16	339	12	1-64	3-32	332	21	1-64	⅛	310
4	1-32	1-16	320	13	1-32	3-32	230	22	1-32	⅛	250
5	1-32	1-16	360	14	1-32	3-32	268	23	1-32	⅛	260
6	1-32	1-16	354	15	1-32	3-32	285	24	1-32	⅛	267
7	3-64	1-16	381	16	3-64	3-32	262	25	3-64	⅛	231
8	3-64	1-16	327	17	3-64	3-32	209	26	3-64	⅛	220
9	3-64	1-16	330	18	3-64	3-32	227	27	3-64	⅛	240

It may be seen from the above that a very high rate of cutting speed was attained throughout, in some instances being truly remarkable, considering the fact that it was on a roughing cut. The lathe withstood this exceptionally heavy duty without a sign of distress. This goes to prove the trend of modern possibilities in rapid work production.

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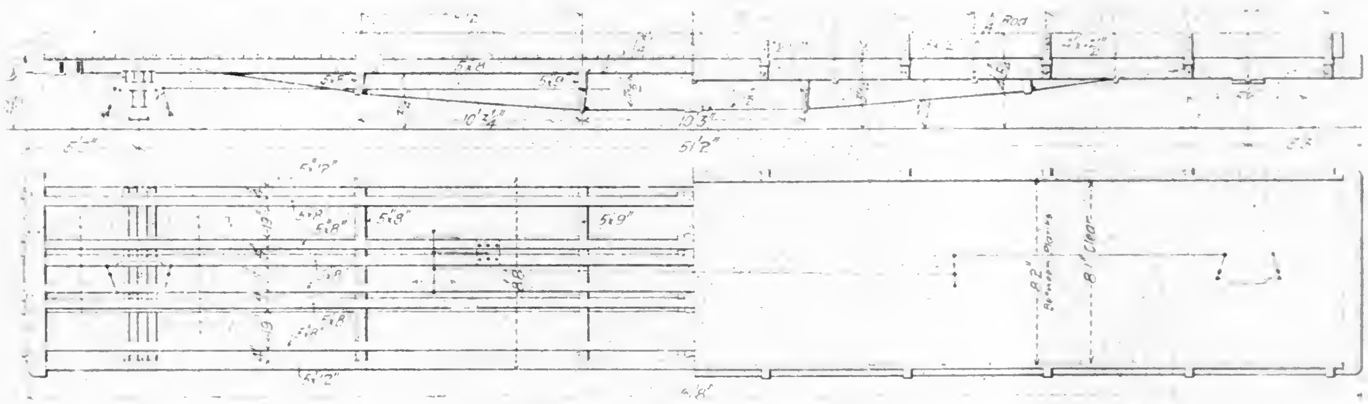

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MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

VIII.

BY C. W. OBERT.

In drilling machines the capacity of the tool is largely dependent upon the rapidity and accuracy with which the driving speed may be changed for adjusting drill spindle speeds to the maximum rates for the various sizes of drills used. The importance of providing a wide range of speeds upon the drive, which are very easily accessible to the operator for this purpose, cannot be overestimated. The Wm. E. Gang Company, Cincinnati, Ohio, have appreciated this need and have recently perfected a new design of radial drill which embodies the desirable feature of a variable-speed drive, the mechanism for which is described in this article.

The principal idea embodied in the design of this device is that of affording a means of getting a greater number of driving speeds than is usually obtainable from cone-pulleys, and of facilitating the changing of speeds. There is one feature which is particularly worthy of note: that is, the ability to reach and control the speeds directly from one point without having to operate a number of levers at different parts of the machine in connection with an index plate. The loss of time incident to an arrangement where the operator is required to read a set of directions and then manipulate a number of levers and gears on different parts of the machine in accordance with those directions is liable to be considerable.

The variable-speed mechanism is illustrated in the engravings, Figs. 39 to 42, and in section in Fig. 43. The general principle mechanically of the device is that of making use of several trains of gears which are capable of several different gear combinations, but the system of clutching and operating levers is decidedly novel. As will be noticed in the engravings, there are three sets of gears of three gears each, a total of nine gears, giving nine speeds, and this number is doubled by the back gears on the spindle of the drill. The gears, ABC, are mounted loosely on shaft S, and gears, D E and F, are mounted loosely on shaft S'. Shafts, S and S', are carried in journals at the ends and are free to slide through the gears and journals. The intermediate gears, X Y and Z, are fast on

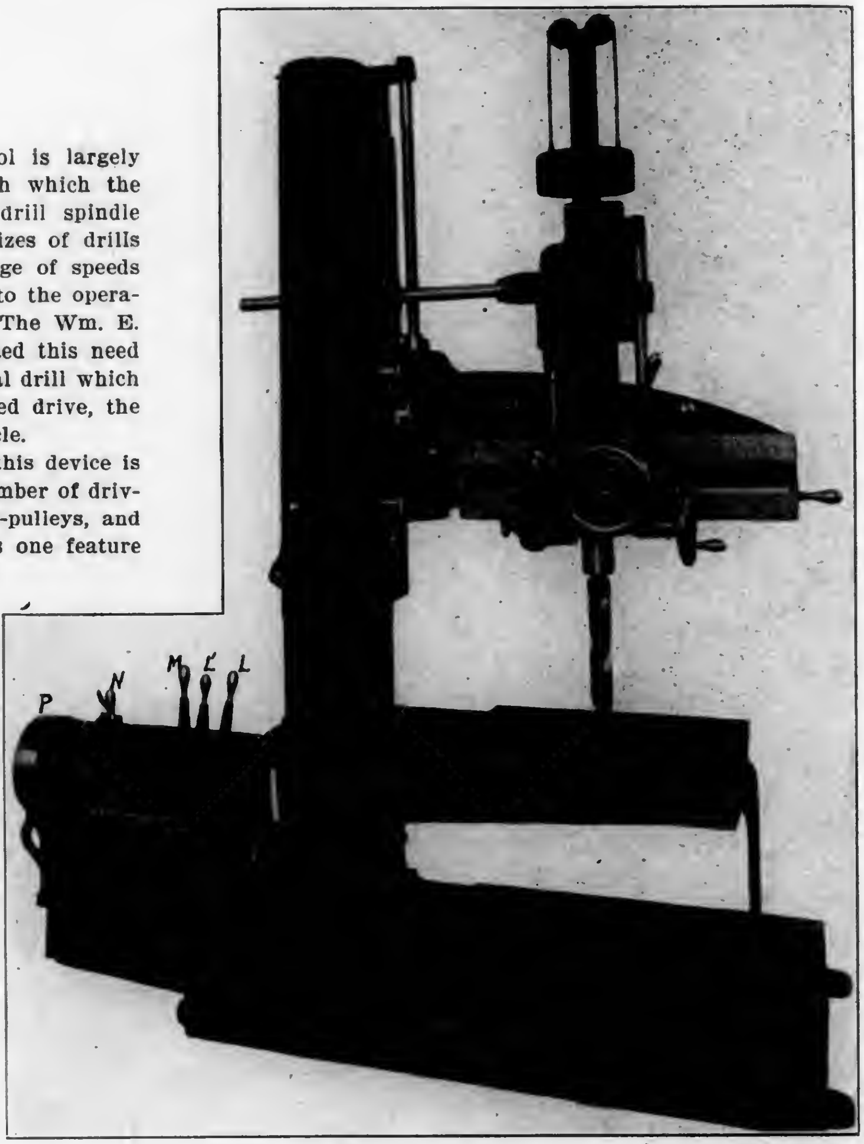

FIG 39.—NEW RADIAL DRILL WITH VARIABLE SPEED DRIVE.—WM. E. GANG COMPANY.

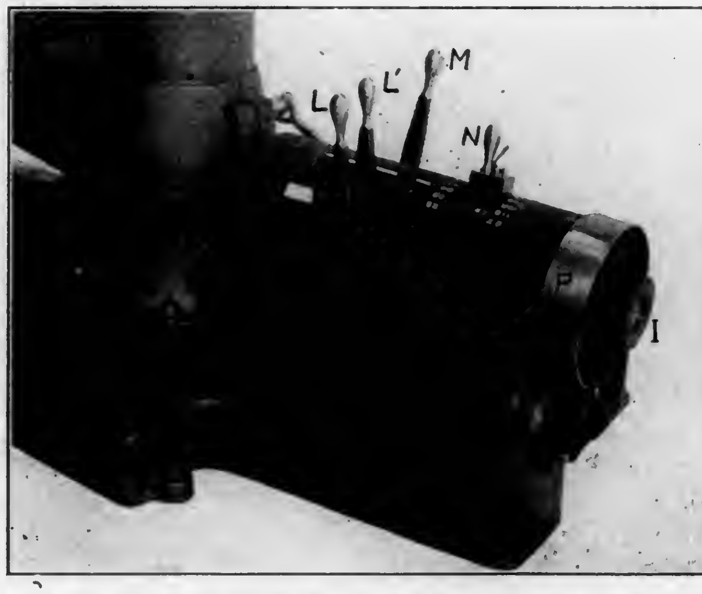

FIG. 40.—REAR VIEW OF THE SPEED BOX, SHOWING CASING FOR INTERMEDIATE GEARS.

FIG. 41.—FRONT VIEW OF SPEED BOX, SHOWING OPERATING LEVERS AND SPEED INDEX.

a shaft and mesh respectively with A D, B E and C F. This gives three trains, thus, AXD, BYE, and CZF.

The shafts, S and S', carry friction rings, O and O', which are operated by means of the sliding wedges, W, and loose collars, G and G'; ring, O, engages in the bores of gears, A B and C, and O' in the bores of gears, D E and F. The driving pulley, P, has a long hub which is journaled in the frame, H, and bracket, I, and is feathered on shaft, S. The dogs, Q and Q', act as fulcrums for the levers, L and L', being loosely mounted

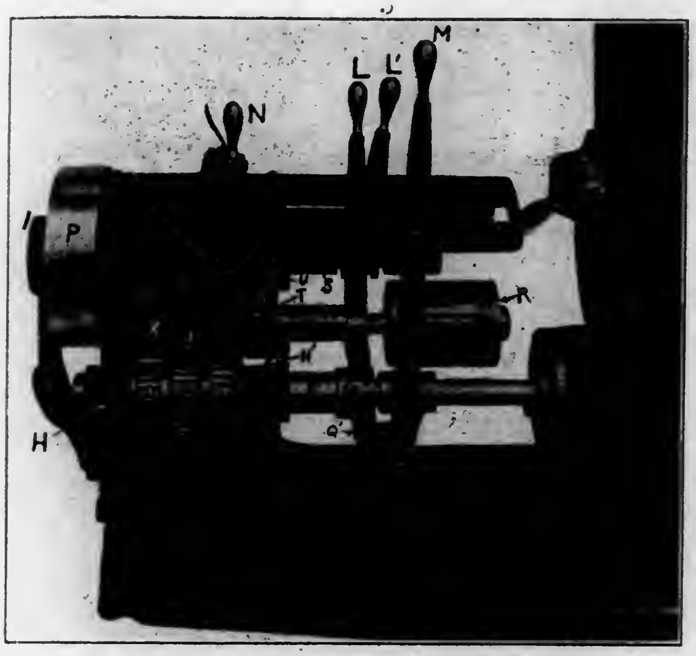

FIG. 42.—INTERIOR VIEW OF SPEED BOX, SHOWING SLOTTED CONTROLLING DRUM.

of shaft, K, and segments, T and U, connected to handle, N. When handle, N, is in position for the speed required, the lever, M, is drawn to the position, 2, as indicated by the full lines, in Fig. 43. This movement locates the friction clutches in the proper gears to give the required speed, and the friction clutches are then set by means of levers, L and L'. The speeds available for the different adjustments of drum, R, are indicated by numbers on the case near handle, N, as shown in Figs. 40 and 41.

The friction rings are operated by taper keys, as shown at W, in the clutch detail in Fig. 43. The action of the lever, L or L', is to force the keys forward and spread the ring, O or O', until it engages with the gear surrounding it. The method of retaining the friction rings in their places upon shafts, S and S', by means of a taper pin, as shown in the detail view, is decidedly interesting.

The design of this device displays remarkable ingenuity. It is very easily operated and embraces a wide speed range, giving as it does a range of 25 to 400 revolutions per minute at the spindle. We are pleased to state that this mechanism has been in service for a very considerable time with very satisfactory results and has proven very effective.

Most satisfactory performance of Babcock & Wilcox boilers on the "Marietta" is recorded by Ensign Henry C. Dinger, U. S. N., in the *Journal of the American Society of Naval Engineers*. The performance of this vessel in the famous run from the Pacific Coast to Cuba in the recent war was sufficient to establish a record for these boilers, but since that time the ship has been in continuous service in the waters of China and the Philippines. "Probably no vessel in the navy during the past five years has steamed as many miles, for the 'Marietta' has logged over 80,000 knots during that period." The repairs have been surprisingly light and they have nearly all been done by the ship's boilermaker and his helpers. This country has not only escaped the uncomfortable and expensive experience of some other nations in the boiler question, but we seem to be ready to begin a development which promises successful and entirely satisfactory results and with no expensive failures to live down. This record of the "Marietta" is remarkable, and it should be borne in mind in connection with the question of water tube boilers in other classes of exacting service.

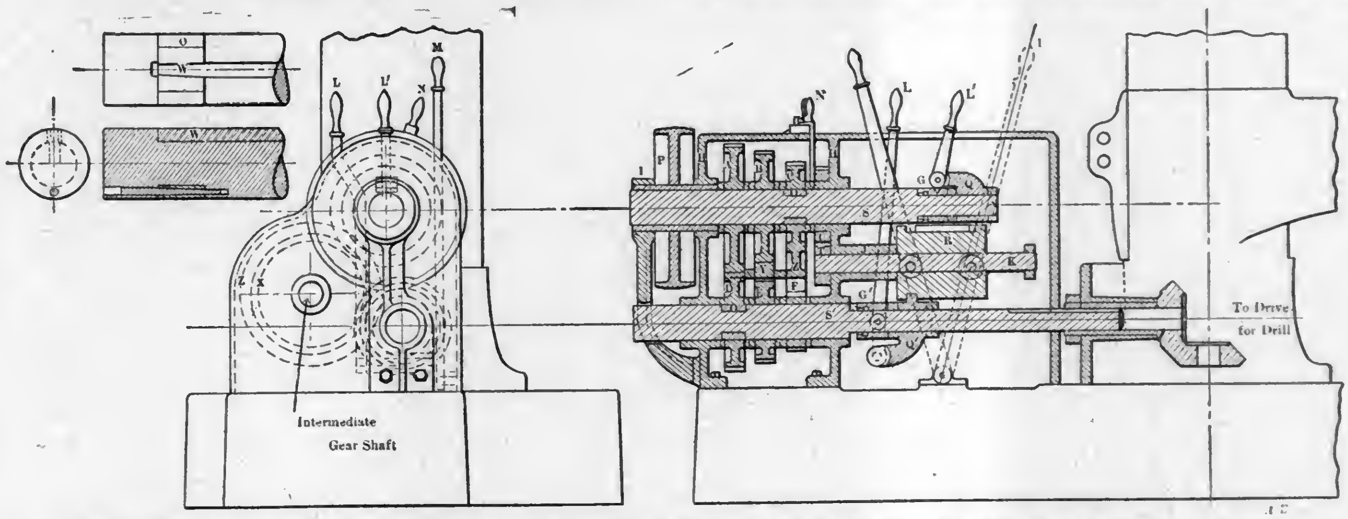

FIG 43.—SECTIONAL VIEW OF SPEED BOX, SHOWING ARRANGEMENT OF GEAR TRAINS AND DETAILS OF FRICTION CLUTCHES.

between collars on shafts S and S', and have projections which engage in the grooves in drum, R; see Figs. 42 and 43.

The drum, R, which is feathered on shaft, K, has one annular groove turned near the end connecting with six long and six short longitudinal grooves. The splined shaft, K, journaled at J, carries a gear segment, T, fast on one end, by which drum, R, on the other end, is rotated. Gear segment, T, meshes with another gear segment, U, which is mounted loosely on the journal of frame, H'. This arrangement is such that the projections on the dogs, Q and Q', engage in slots on opposite sides of drum, R, and the action in indexing to obtain a given speed is as follows:

Lever, M, is drawn to position, 1, as indicated by the dotted lines in Fig. 43, thereby sliding the drum, R, which by means of the grooves engaging the dogs, Q and Q', draws shafts, S and S', with it. The friction clutches are now in gears, C and F, and the projections on dogs, Q and Q', being in the annular groove in drum, R, permits the drum to be revolved by means

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The real desideratum which is achieved by the application of electric-motor driving is the increased output from the machinery—this far outweighs in importance the several other advantages incidental to electric driving, such as the saving of head-room, the absence of long lines of shafting, the avoidance of power wastes, etc. In reality economy of power is of little importance, inasmuch as its value, whether furnished by shafting or by a motor, is nearly negligible when compared with the importance of increased product.

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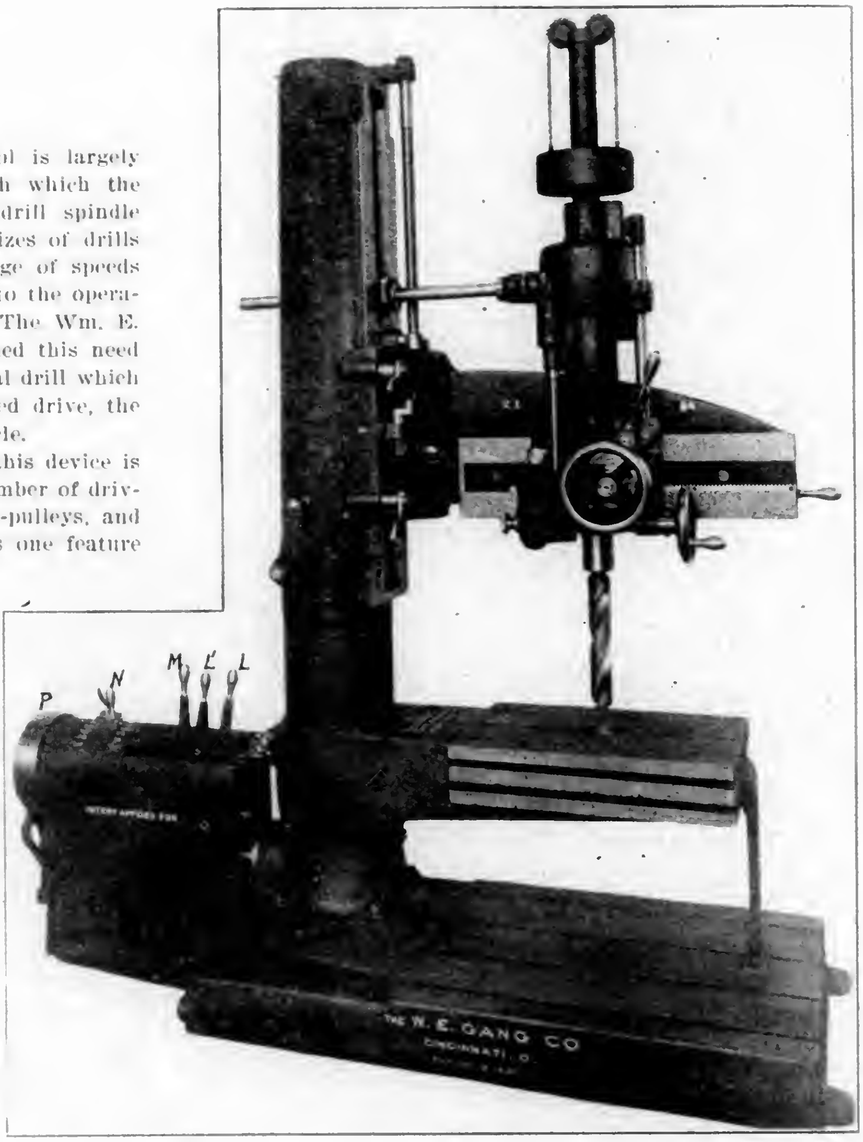

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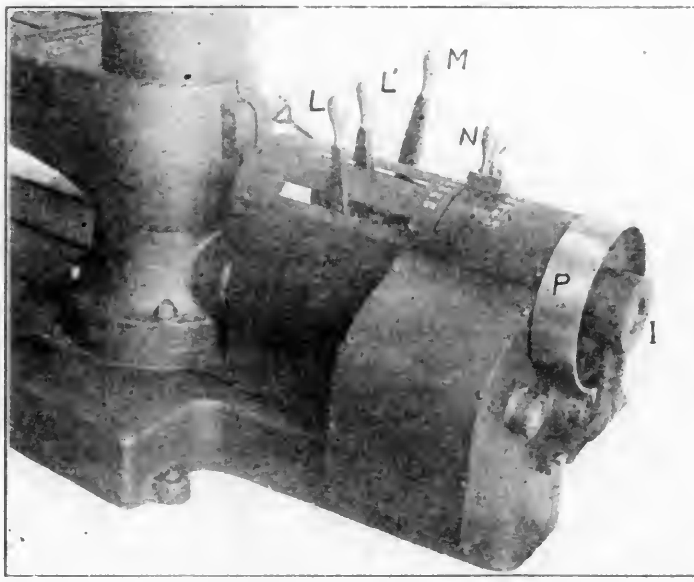

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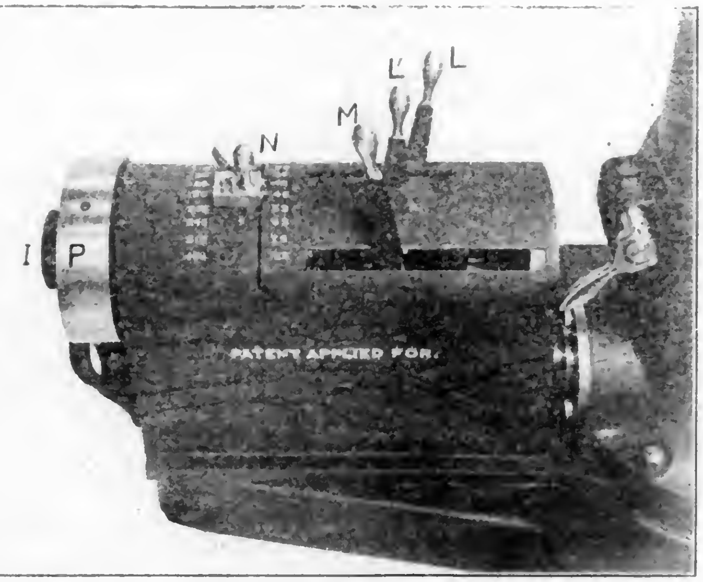

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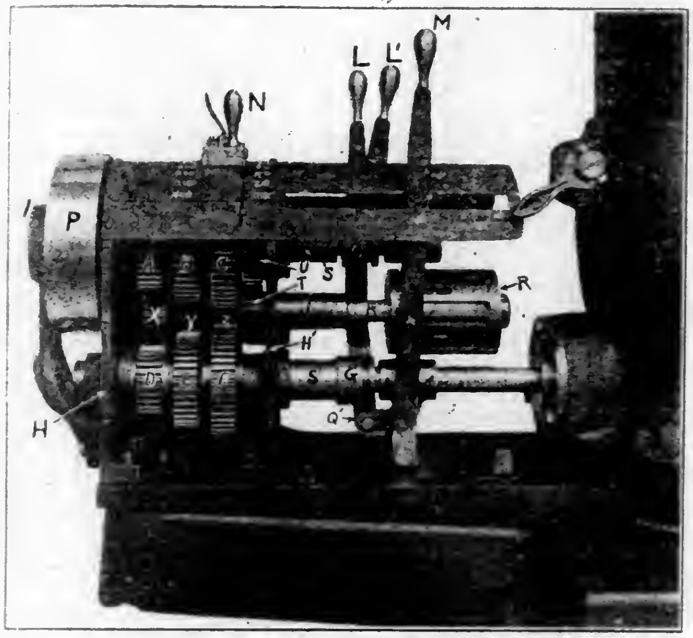

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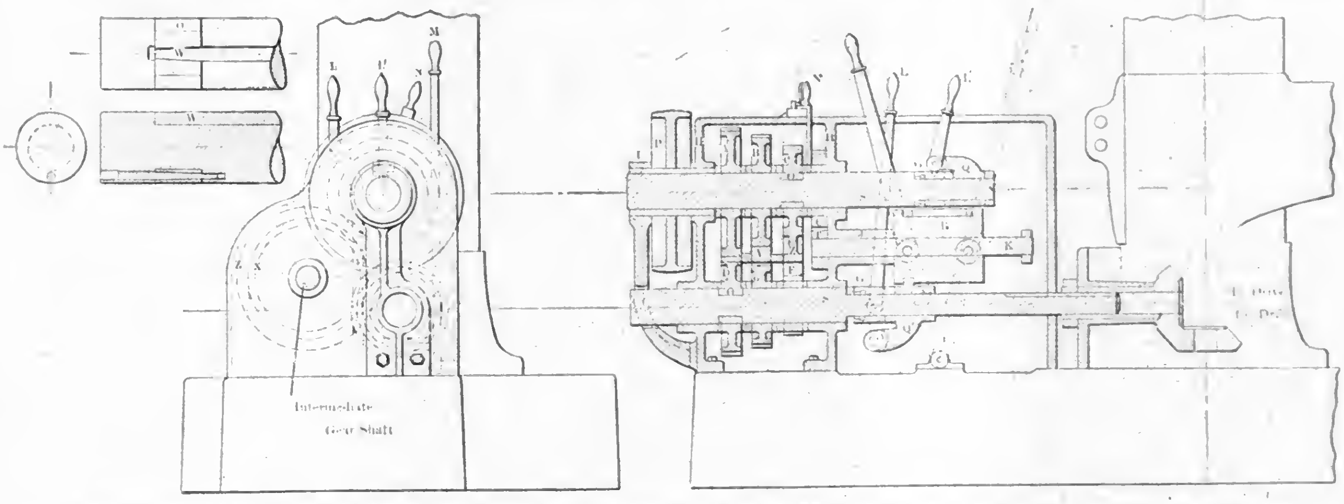


FIG. 43.—SECTIONAL VIEW OF SPEED BOX, SHOWING ARRANGEMENT OF GEAR TRAINS AND DETAILS OF FRICTION CLUTCHES.

between collars on shafts S and S', and have projections which engage in the grooves in drum, R; see Figs. 42 and 43.

The drum, R, which is feathered on shaft, K, has one annular groove turned near the end connecting with six long and six short longitudinal grooves. The splined shaft, K, journaled at J, carries a gear segment, T, fast on one end, by which drum, R, on the other end, is rotated. Gear segment, T, meshes with another gear segment, U, which is mounted loosely on the journal of frame, H'. This arrangement is such that the projections on the dogs, Q and Q', engage in slots on opposite sides of drum, R, and the action in indexing to obtain a given speed is as follows:

Lever, M, is drawn to position, 1, as indicated by the dotted lines in Fig. 43, thereby sliding the drum, R, which by means of the grooves engaging the dogs, Q and Q', draws shafts, S and S', with it. The friction clutches are now in gears, C and F, and the projections on dogs, Q and Q', being in the annular groove in drum, R, permits the drum to be revolved by means

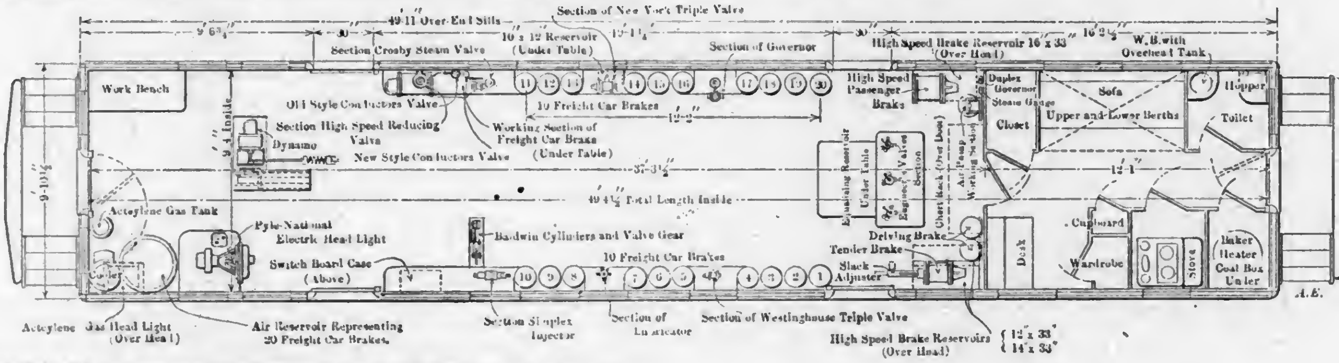
not only escaped the uncomfortable and expensive experience of some other nations in the boiler question, but we seem to be ready to begin a development which promises successful and entirely satisfactory results and with no expensive failures to live down. This record of the "Marietta" is remarkable, and it should be borne in mind in connection with the question of water tube boilers in other classes of exacting service.

The real desideratum which is achieved by the application of electric-motor driving is the increased output from the machinery—this far outweighs in importance the several other advantages incidental to electric driving, such as the saving of head-room, the absence of long lines of shafting, the avoidance of power wastes, etc. In reality economy of power is of little importance, inasmuch as its value, whether furnished by shafting or by a motor, is nearly negligible when compared with the importance of increased product.

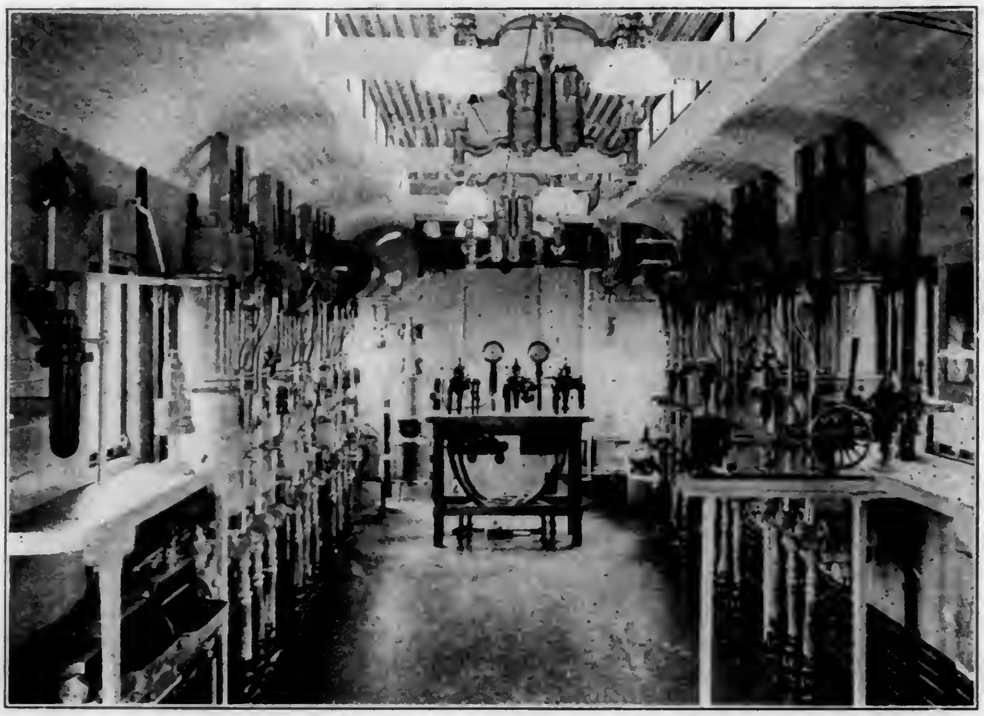
INSTRUCTION CAR.

Atchison, Topeka, & Santa Fe Railway.

The Santa Fe has recently equipped a new instruction car, the arrangement of which is shown in the accompanying plan. A postal car 50 feet long was rebuilt for this purpose and it contains an unusual equipment of apparatus, a large proportion of which is working mechanism, and this is accompanied by other apparatus sectioned in order to facilitate instruction. Notations on the plan indicate the location and description of the apparatus, making a list of the features of the equipment unnecessary. It includes the high-speed brake, electric headlight and turbine, injectors, and the ordinary brakes. As this road has a large amount of electric-lighting apparatus for passenger cars with generators driven from the axle, a generator is placed in the car for instruction purposes. About 100 cars are now running on this road with "axle light." Instead of being hung from the truck in the usual way, this generator is mounted on the floor of the car so that it may be studied and described. It also serves to light the car, and represents the equipment as it is actually in use. Instead of providing a compressor, this car is supplied with compressed air from a locomotive or from the yard piping systems at terminals where it is stationed. We are indebted to Mr. G. R. Henderson, formerly superintendent of motive power, for this information.



Quantzintecomatzin is the name of a car operated by the American Tourist Association. This car is said to have the usual number of truss rods, but there must be some concealed steel work in the frame in order to carry such an extraordinary load. "What's in a name?" There appears to be everything in this one.



AIR BRAKE INSTRUCTION CAR.
ATCHISON, TOPEKA & SANTA FE RAILWAY.

MOTOR-DRIVEN MACHINE TOOLS.

THE LATEST PRACTICE IN APPLYING INDIVIDUAL DRIVES TO SHAPERS.

In the July issue there were illustrated, in an article appearing under the above heading, a number of interesting applications of motor driving to shapers. We have often heard the opinion offered that it is entirely unnecessary to attempt the application of motor-driving to tools as small as shapers, but the importance that is coming to be attached to this use of motor-driving can best be judged from the number of motor-driven shapers that are being developed by the most prominent machine-tool builders. In this article are supplemented further interesting examples of motor-drive applications to shapers, for both constant-speed and variable-speed driving.

The upper engraving on page 291 represents two views of a very interesting type of motor-drive that the Hendey Machine Company, Torrington, Conn., are applying to their pillar shapers. The shaper here illustrated is the 24-in. Hendey rack shaper with friction-clutch drive. The support for the motor is very conveniently provided for by a small cast iron bracket which is bolted to the rear of the machine's frame, thus in no way necessitating any alteration in the construction of the tool. This bracket is provided with V-ways and an adjusting screw to permit of moving the motor foot-plate for tightening the belts. A valuable feature of this method of mounting the motor is that of the small amount of additional working space required by the tool when thus equipped.

The motor used in this drive is a 2-h.p. direct-current multipolar motor, of the back-geared type, built by the Northern Electrical Manufacturing Company, Madison, Wis. The back-geared motor is particularly advantageous for driving a rack shaper, as while the low speed of the back-gear shaft is adapted for the forward, or cutting stroke of the ram, the high speed of the armature shaft is directly applicable to the quick-return motion of the ram, and the directions of rotation harmonize. This is carried out in the drive by belting from the armature

shaft direct to the quick-return pulley and from the back shaft direct to the forward-motion pulley, the necessity of crossing belts being thus dispensed with entirely. The back-shaft speed is properly reduced to admit of the use of the same sized driving pulley as regularly used, thus affording full power to the cutting stroke. Two different cutting speeds are also available at the ram by means of the two-stepped cone pulleys on the forward-motion drive.

The motor operates at a constant speed, at its maximum efficiency; it is controlled by a main switch and a starting box at the right side of the frame, conveniently accessible to the operator. The starting box is covered by a small hooded shelf for protection from metal chips, dirt, etc., from falling upon it, as shown. The sizes of motors recommended by the Hendey Company for their various sizes of shapers are as follows:

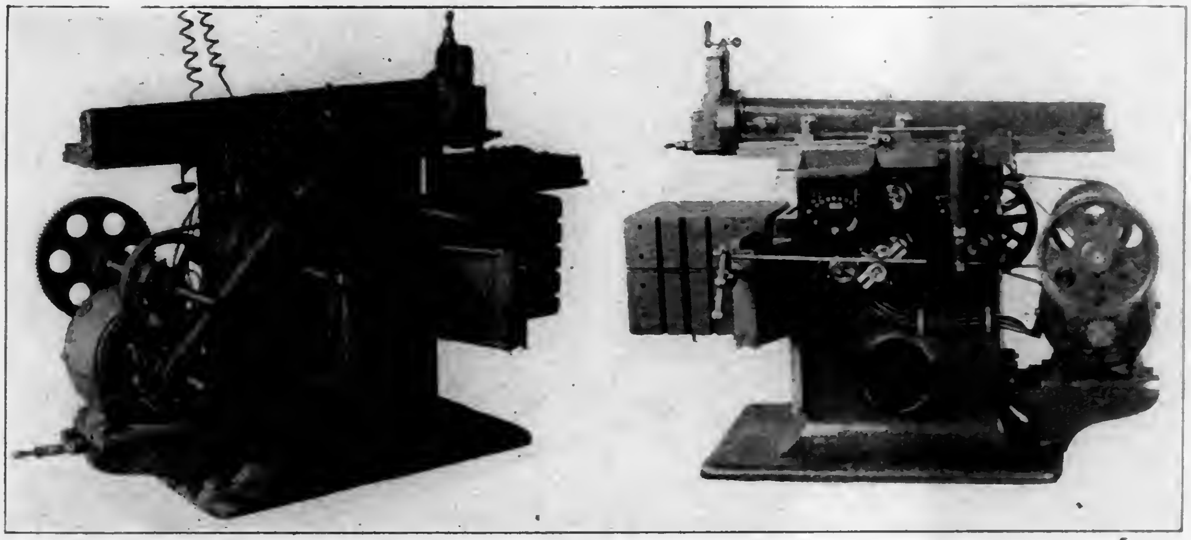
Size of Shaper..............	15 in.	20 in.	24 in.	28 in.
Horse Power of Motor.......	One	Two	Two	Three

The engraving on page 292 illustrates a very interesting motor-drive application upon a shaper which is similar to the above in principle. The machine shown is the 30-in. geared, draw-cut shaper, built by the Morton Manufacturing Company, Muskegon Heights, Mich. The motor in this case also is supported by a bracket at the rear of the frame, although no motor adjustment for belt tightening is here necessary. The drive is made through a countershaft which is permanently mounted above the pillar upon a neat bracket or stand.

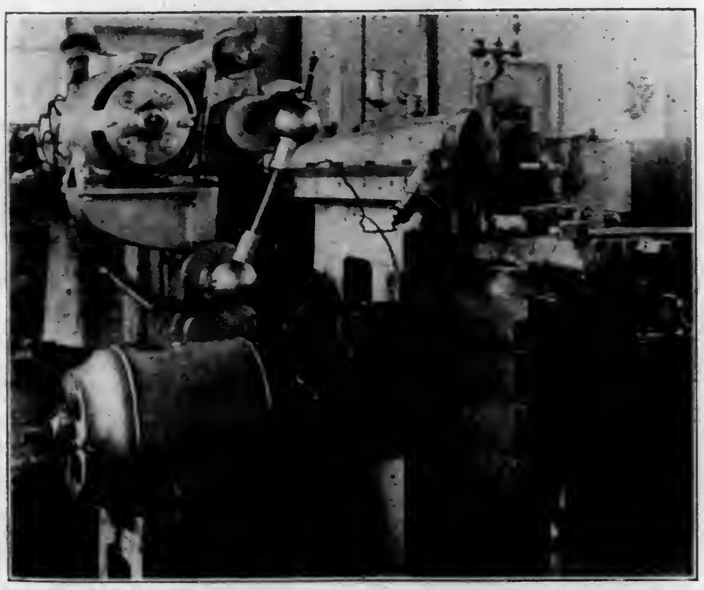
The motor used for this drive is also a constant-speed direct-current motor, being in this case furnished by the General Electric Company. It is controlled by a starting box and main switch, both of which are located on the right side of the frame for convenient access to the operator. The drive is further made flexible by the use of a friction-clutch on the countershaft for starting and stopping the machine independent of the motor. The reciprocating motion is obtained for the ram by open and cross belts and special automatic-relieving clutches, the driving pulleys being proportioned for a quick-return stroke of 3 to 1.

The principle for which this shaper is particularly noted is that of the "drawing" cut, whereby the thrust of the cut is placed directly against the column of the machine, thereby having a tendency of drawing the bearings closer together and making the machine more accurate. The construction of the machine is such that it will work close to a line and will reverse at the extremity of its stroke without shock or jar. It is of the geared type and gives an even motion through the entire cutting stroke. The gearing throughout is cut from the solid, and the stroke is adjusted by tappets on a circular disc. On ordinary cast iron work a cut 1 in. deep with 1-13-in. feed is carried by this machine with ease.

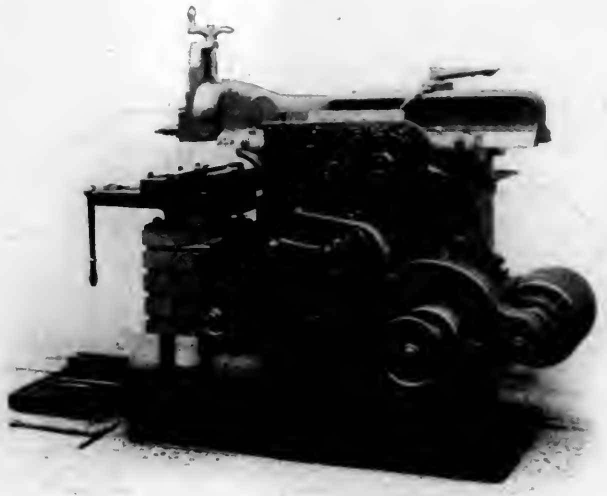
The Morton Manufacturing Company have made several experiments in applying motor drives to their different tools and have always found it advisable to employ a belt drive from the motor for their particular line of tools. They use



LEFT AND RIGHT-HAND VIEWS OF MOTOR-DRIVEN 24-IN. HENDEY-NORTON RACK SHAPER.—HENDEY MACHINE COMPANY.



VARIABLE-SPEED GEARED DRIVE, 16-IN. SMITH & MILLS CRANK SHAPER AT THE WORKS OF THE BULLOCK ELECTRIC & MANUFACTURING COMPANY.



VARIABLE-SPEED GEARED DRIVE UPON THE "QUICK-STROKE" SHAPER BUILT BY GOULD & EBERHARDT.

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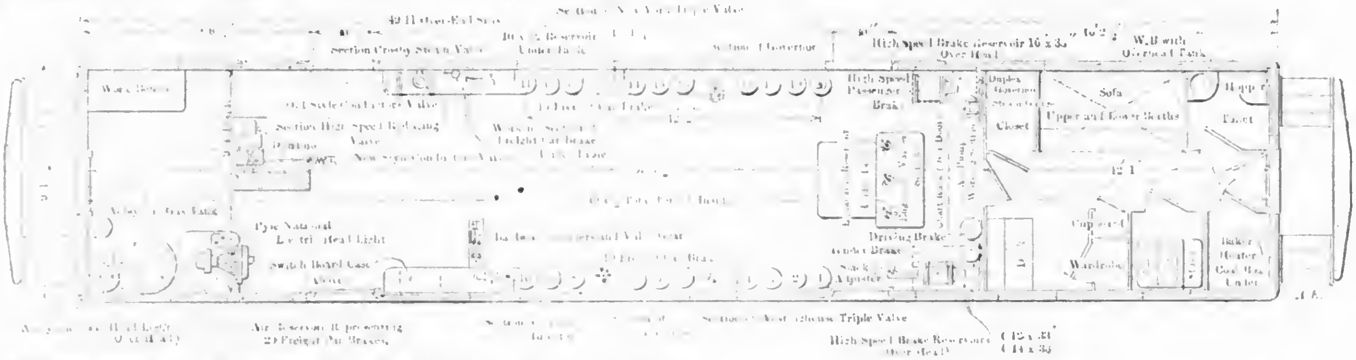

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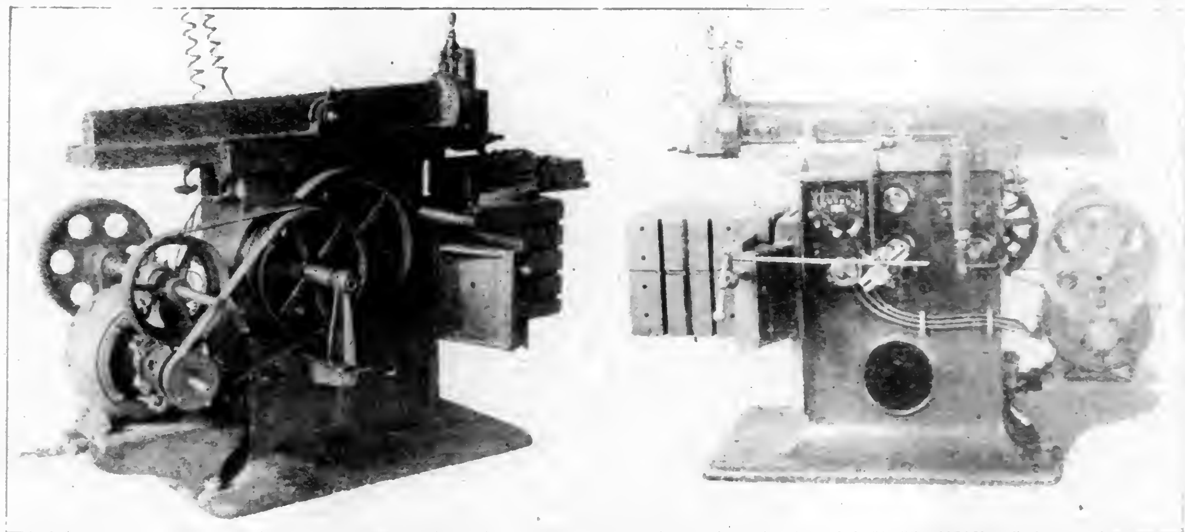
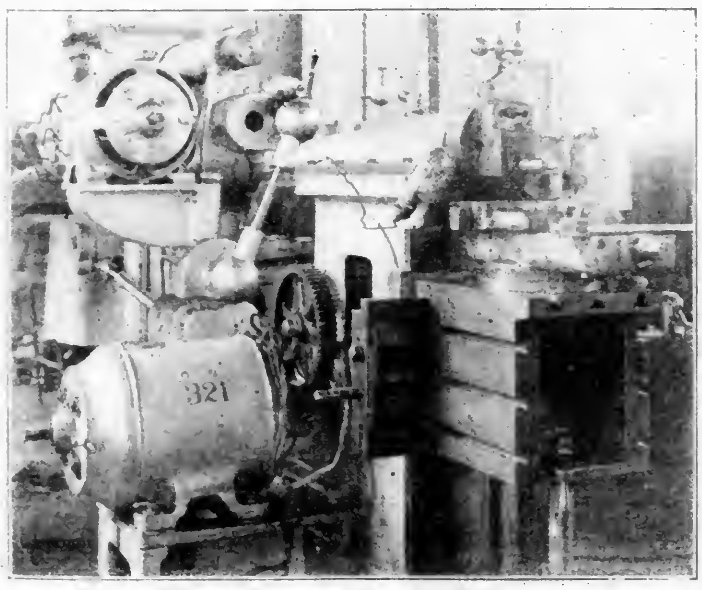


LEFT AND RIGHT-HAND VIEWS OF MOTOR-DRIVEN 24-IN. HENDEY-NORTON RACK SHAPER.—HENDEY MACHINE COMPANY.



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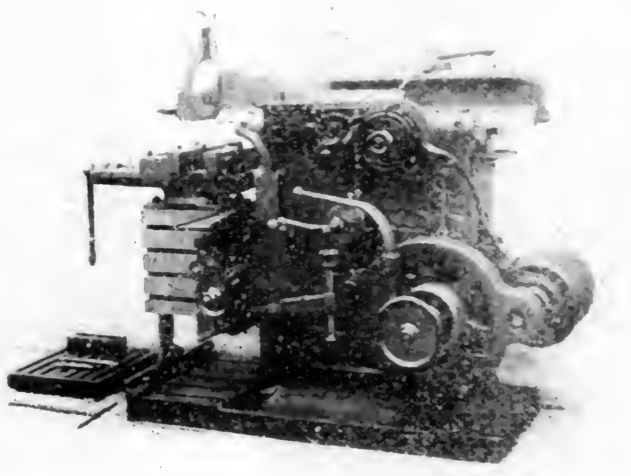


VARIABLE-SPEED GEARED DRIVE UPON THE "QUICK-STROKE" SHAPER BUILT BY GOULD & EBERHARDT.

friction clutches for obtaining the reciprocating motion for shapers and find that they thus obtain better results, as there is a slight chance for slippage of the belts.

The lower right-hand engraving on page 291 is an illustration of the latest type of variable-speed drive which has been developed by Gould & Eberhardt, Newark, N. J., for their new "quick-stroke" shaper. The motor is in this case very conveniently mounted upon the rear of the pillar and drives the crank-gear shaft through a rawhide pinion on the armature shaft, and a friction clutch, which is operated by the large handle at the front of the machine. The space occupied by the drive is very small and it is to be noted that no special bracket is required to support it.

The motor is a Storey variable-speed motor, using field control for the range of speeds. It is controlled by a main knife switch and a starting box at the right of the ram, and also there is added a rheostat for the field control of speeds. This speed range is doubled by a back-gear attachment on the driving shaft which is easily operated by a slip gear controlled by a handle above the motor. The motor and the entire range of speeds are thus easily handled from the front of the machine, the entire range of speeds available at the ram of from 5 strokes per minute when back geared to 100 strokes per minute single geared being very easily obtainable, thus making it possible to vary the tool speed to best suit the working conditions for performing short operations.

To make the back-gear change, the pinion-shaft is unclutched by a slight movement of the clutch-lever at the front of the machine, which lever operates also a brake, enabling the machine to be stopped immediately; after throwing over the slip-gear for the back-gear the clutch is thrown in again. The large hand-wheel on the outer end of the pinion-shaft, in front of the clutch, gives a convenient hand movement of the ram for use in setting the tool. An important feature of the drive of this tool is that all shafts run in cylindrical bushes held in bored seats in the frame, so that they may be cheaply and easily renewed without change of the original alignment.

The remaining engraving on page 291 illustrates a variable-speed drive that has been applied to a 16-in. Smith & Mills crank-shaper at the works of the Bullock Electric and Manufacturing Company, Cincinnati, Ohio. The method of mounting the motor here used is that of supporting it upon a small cast-iron platform at the left of the tool so as to permit the motor to gear direct with pinion-shaft gear. This makes a very simple and direct drive, and requires but little space.

The motor is one of the standard type N Bullock motors, operating on the multiple-voltage system. It has a maximum speed of 950 revolutions per minute with a voltage of 250 volts, and has a capacity of 2¼-h.p. The variable speeds are obtained through the agency of a multiple-voltage controller which is mounted at the right of the ram, as shown. In this way a wide range of speeds is available without back gear or gear changes, and it is easily changed from the front of the machine.

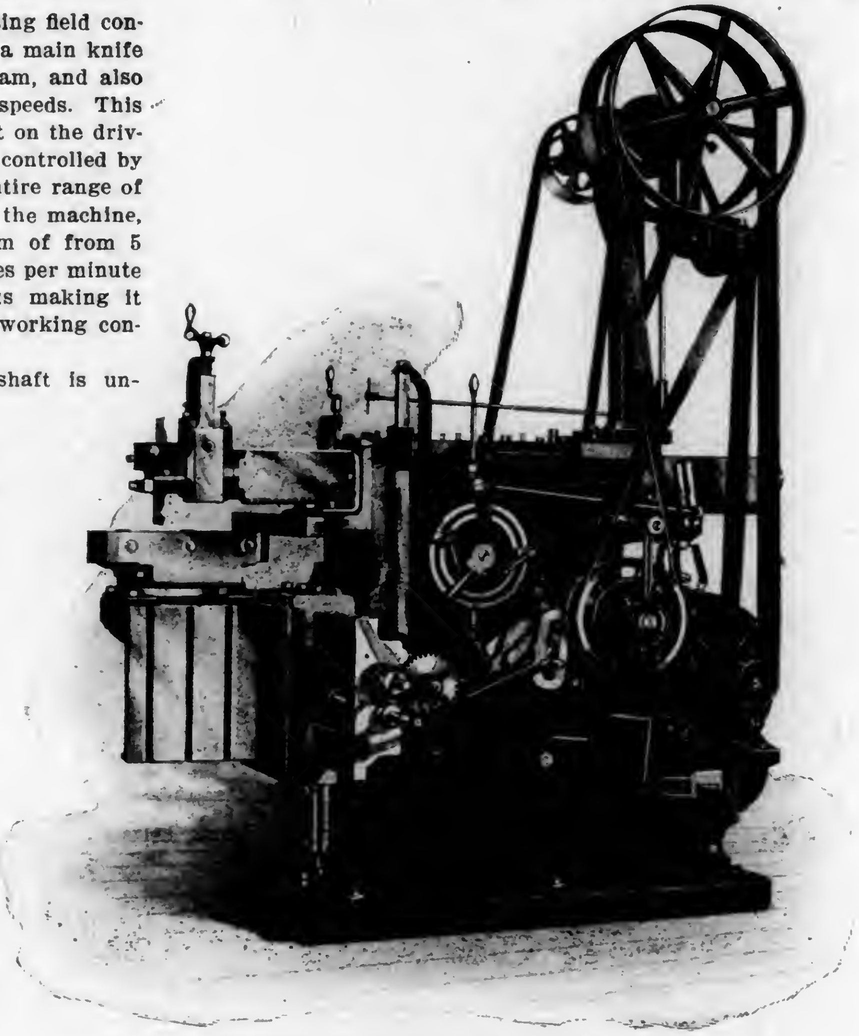
In the background in the latter engraving is shown an interesting variable-speed motor-drive upon a milling machine built by the Cincinnati Milling Machine Company. The motor, a type N multiple-voltage Bullock motor, is mounted upon a bracket at the rear of the headstock and is geared direct to the spindle.

IDEAL SMALL CAR REPAIR SHOP.

Mr. G. N. Dow, master car builder of the Lake Shore & Michigan Southern Railway at Cleveland, presented before the Master Car Builders' Association a description of what he considered an ideal arrangement for a repair shop for a yard handling 2,500 cars per day. The plant is at Ashtabula, Ohio.

This arrangement consists of three long tracks holding 30, 33 and 46 cars, two short tracks used for heavy repairs holding 12 cars each and one short track holding 14 cars for loading and unloading material. The short tracks are located between the long tracks and each end of the building. There is also centrally located between the long tracks a building 216 ft. long and 26 ft. wide, a shed 100 ft. long and 16 ft. wide, which is used for storing manufactured material such as couplers, bolsters, end sills and draft timbers, a scrap bin 50 ft. long and 14 ft. wide, also a platform for storing wheels; two buildings 60 ft. long, 9 ft. wide and 7 ft. high, located south of the tracks and in the center of the plant. One is used as a mess-room, being equipped with lockers for men's clothes, two long sinks and benches; the other building is used for storing the men's tools and is equipped with shelves or racks. Parallel with each long track and between the short ones there is an 18-in. gauge track equipped with low four-wheel cars used for distributing material, tools and wheels. The general foreman's office is located in the southeast corner of the building. This entire plant is equipped with air, using 1¼-in. pipe having connections every 100 ft. apart for testing cars. The entire yard, including the space between the tracks, is planked with 2½-in. oak plank, which is easy to keep clean, and gives the entire plant a neat appearance and also gives a good foundation for jacks when jacking cars. It also reduces the labor in changing wheels, besides assuring a dry yard for the men to work in.

We repair at this plant on an average of 200 cars every working day with a force of 60 men. All classes of repairs are made, from changing couplers to rebuilding complete. For the last five months we have averaged per month 400 couplers changed, 126 pairs of wheels changed and 104 longitudinal sills applied. The month of March, 1903, was our heaviest month for wheels and sills, changing 199 pairs of wheels and 196 longitudinal sills.



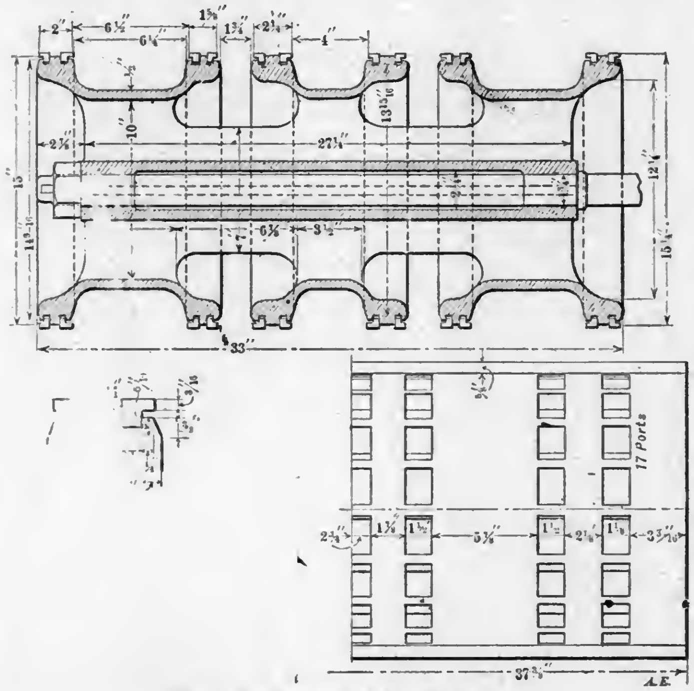
BELTED COUNTERSHAFT DRIVE UPON 30-IN. GEARED DRAW-CUT SHAPER.—MORTON MANUFACTURING COMPANY. CONSTANT-SPEED MOTOR.—GENERAL ELECTRIC COMPANY.

PISTON VALVE FOR FOUR-CYLINDER BALANCE COMPOUND.

Baldwin Locomotive Works.

In illustrating the Vauclain balanced compound locomotive, built for the Plant System (American Engineer, March, 1902), the valve was omitted from the details because it merited an explanation which could not be given at that time. The details of this valve are of greater interest because of the recent construction of four locomotives on the same system for the Atchison, Topeka & Santa Fe Railway.

The accompanying drawing of the valve and bushing and the sketch showing the cylinders and ports makes its operation clear. The simple construction is worthy of record. One valve, 15 ins. in diameter, serves both cylinders on one side of the engine. The valve is hollow and very light. It takes



DETAILS OF VALVE AND BUSHING.

steam at the center and places the valve stem under receiver pressure only. By following the courses of the arrows the operation of the valve is made clear and it should be noted that the ports to the low pressure cylinder are very short, giving to that cylinder very small clearances. This valve has been patented by Mr. S. M. Vauglain, of the Baldwin Locomotive Works. It is illustrated now because of a request from a correspondent who has become interested in the recent articles in this journal on the subject of the four-cylinder compound in France.

PERSONALS.

Mr. G. R. Henderson has resigned as superintendent of motive power of the Atchison, Topeka & Santa Fe Railway.

T. A. Mackinnon, first vice-president and general manager of the Boston & Maine Railroad, died suddenly July 12 at Marblehead, Mass.

George S. Morison, engineer of nine bridges over the Mississippi and Missouri rivers, and many other equally important works, died in New York July 1.

Mr. E. D. Nelson has been appointed engineer of mechanical and electrical tests of the Pennsylvania Railroad, with headquarters at Altoona. This is an office created to meet the need for an experienced officer who can take the entire responsibility for the important investigations which this road conducts in the study of its problems. The fact that the road is building a locomotive testing plant at Altoona and that the dynamometer, building at the works of Wm. Sellers & Co., is to have a capacity of 80,000 lbs., indicates the broad scope of the development which Mr. Nelson is to have in charge. He is transferred to this position from that of superintendent of motive power of the Philadelphia & Erie Division at Williamsport, Pa. He is succeeded by Mr. R. K. Reading, master mechanic at West Philadelphia.

Pulaski Leeds, superintendent of motive power of the Louisville & Nashville, was fatally shot by an employee of the road July 6 and died the next day. The shots were fired by G. B. Werner, electrician of the road, who immediately committed suicide. This sad affair removes one of the best-known motive power officers of the country. He was a large man and big-hearted, although his kindly nature was not always seen through a sometimes bluff manner. Several years ago the

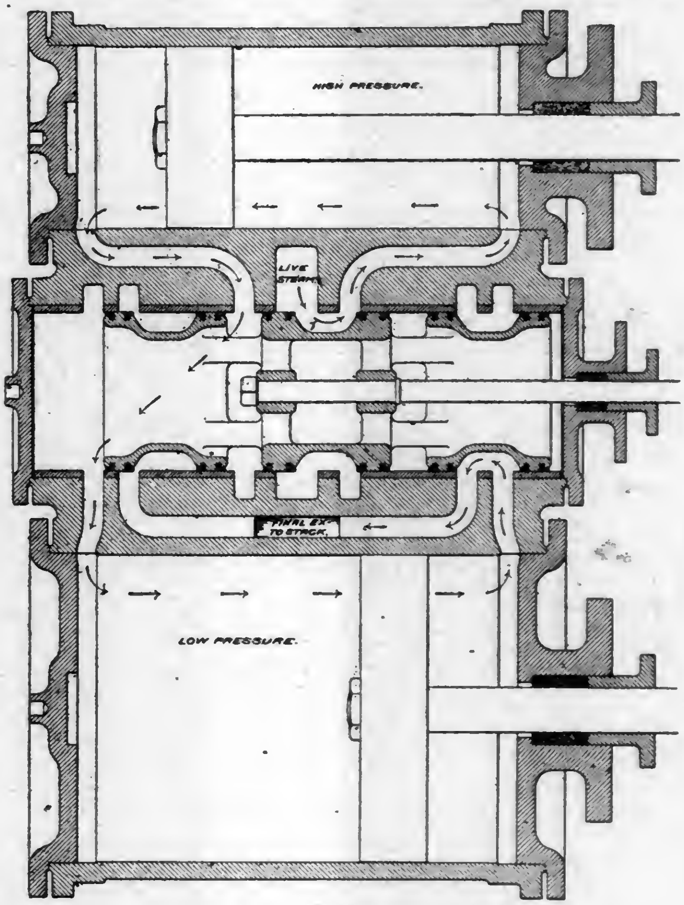


DIAGRAM OF VALVE AND CYLINDERS.

writer had the privilege of seeing Mr. Leeds relieve the evident distress of a little child who was lost in the streets of Louisville. He was never too busy to do such an act of kindness and he was a man who naturally made strong friendships. Mr. Leeds was born in Connecticut in 1845 and began railroad service in 1861 as machinist apprentice on the New York & New Haven Railroad. In 1877 he was appointed superintendent of motive power of the Boston & New York Air Line. In 1882 he went to the Louisville & Nashville as master mechanic and in 1889 became superintendent of motive power. He will be greatly missed.

Not over 30 per cent. of the machine tools used in railroad repair shops require special provisions for varying cutting speeds—the usual method of changing speeds by belt and cone pulleys, or by gearing, is sufficient for most requirements. The remaining 70 per cent. of the tools can thus be conveniently driven by constant-speed motors, for which purpose the induction (alternating current) motor is preferable on account of its great simplicity, the absence of commutators or other exposed current collecting devices, and its extensively proven reliability.—L. R. Pomeroy, before the Central Railroad Club.

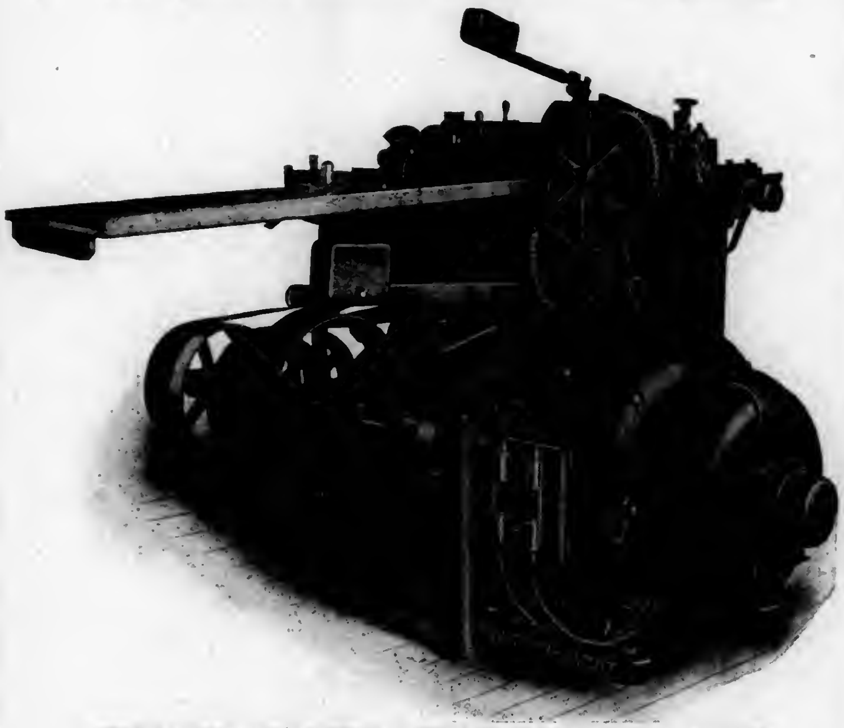
WOODWORKING MACHINERY.

IMPORTANT DEVELOPMENTS IN INDIVIDUAL DRIVING BY ELECTRIC MOTORS.

The principle of driving wood-working machines either individually or in groups by electric motors has come to be regarded as a necessary feature of the equipment of every modern wood-working establishment, whether in a railroad shop or elsewhere. The importance of the electrical system transmission of power is being realized, and during the last few years both builders and users have given the subject special consideration.

As our readers are doubtless aware, the advantages to be gained from the electric power transmission and driving are numerous, but the most important may be treated under the following heads: First, saving of power; second, decreased cost of maintenance; third, increased output, and, fourth, convenience and flexibility.

The saving of power through the direct driving of wood-working tools by electricity is a matter of the highest importance. Tests have brought to light instances where five-sixths of the power developed in the ordinary engine room was dissipated in the shafting and belting, this with every machine running at full load, a condition seldom reached in practice, and the maximum of efficiency of the plant proved to be only 30 per cent. This is an abnormal case, however, and is the exception rather than the rule.



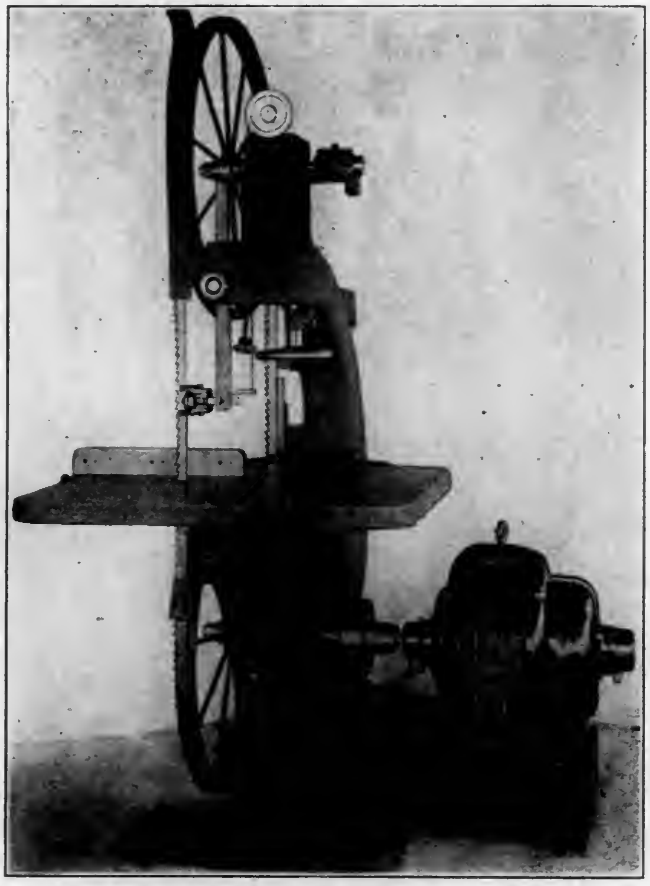
DIRECT-CONNECTED INDIVIDUAL DRIVE UPON AN OUTSIDE MOULDER BUILT BY THE S. A. WOODS MACHINE COMPANY.

The quantity of power required to drive wood-working machinery varies enormously according to the character and quality of the lumber worked, the speed of feed, the depth of cut and more particularly the *condition of the knives, teeth and other cutting edges*. The importance of keeping the cutting edges in good order will be apparent when it is understood that a given amount of work, on either green or dry lumber, may easily require an expenditure of 300 per cent. more power when the knives or cutters are dull than when they are sharp. Again, the power required by the machine itself is very much greater than that required by a metal-working tool of corresponding size, and when this large amount of power is to be transmitted through considerable belting and long runs of shafting, the losses in transmission are great.

As to the decreased cost of maintenance, in eliminating the major portion of shafting and belting, as is the case when electric power is used, a large and unending expense is avoided. With no shafting to lubricate, no belts to renew or repair and no annoyance from loose pulleys, there is little difficulty in keeping machinery running and the men productively employed. With electricity as the motive power, the horse-power required to run a given plant is less than with steam and a considerable amount of money is saved in coal consumption.

There is no question as to the increase of output, as actual returns from plants that are now operated by electricity show that the output has been increased from 10 to 30 per cent.

With respect to convenience and flexibility, no system of belt and shaft drive can possibly compare with electricity. Where formerly it was necessary to place machinery in a certain position relative to the main or auxiliary shafts, now, with the individual motor-drive, the machinery may be disposed according to the needs of the tools, the available floor space, or with reference to the other conditions that may arise, and if it should be necessary to rearrange the tools it can readily be done. By the use of motors, the machines may always be set up where they are most convenient for the work in hand, without regard to the source of power, and, furthermore, any section of the plant can be operated independent of the other. This opportunity for subdivision is exceedingly valuable when, in running overtime or in other emergencies, one department is enabled to work without waste of energy while the remainder of the plant is at rest. As regards the overhead room obtained by the abolition of shafting, it is in many cases necessary to operate the traveling cranes, and these can be used without any difficulty in shops where the system of individually driving the machines by motors is in vogue.



DIRECT-CONNECTED DRIVE ON 36-IN. BAND SAW.—S. A. WOODS MACHINE COMPANY.

Among the foremost to take up and investigate the question of motor-driving for wood-working tools was the S. A. Woods Machine Company, South Boston, Mass. This company has had this subject under investigation for a long time and has gained valuable experience. As a result they are redesigning a number of their tools to conform to the requirements of the motor drives, and have met with most excellent results, not

only as to the simplicity of the machine equipments but also with respect to the service performed. We are permitted to illustrate herewith a few representative motor drives which have been designed by this company.

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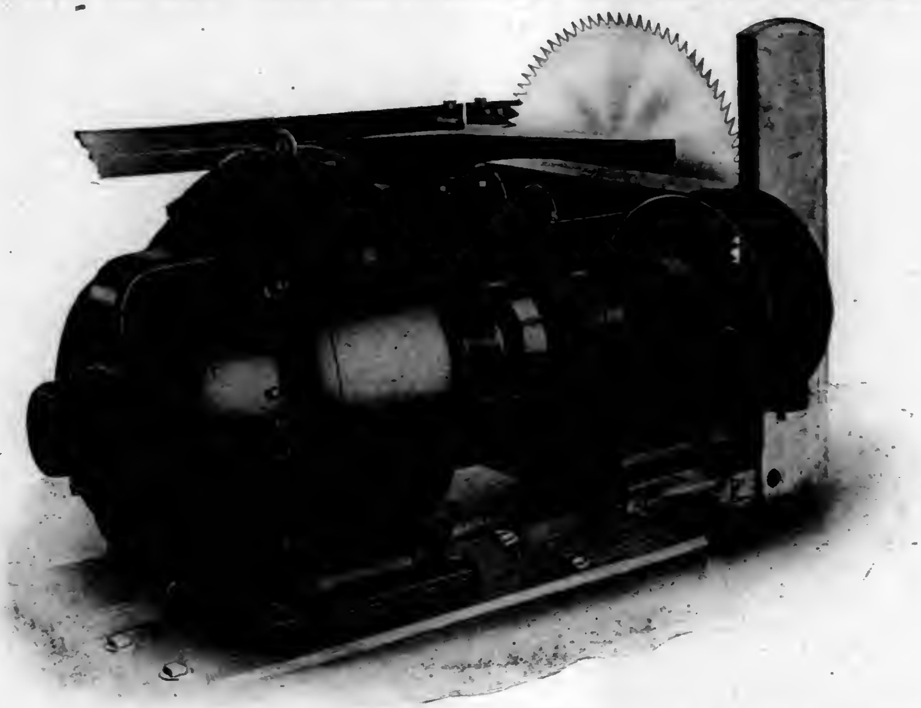
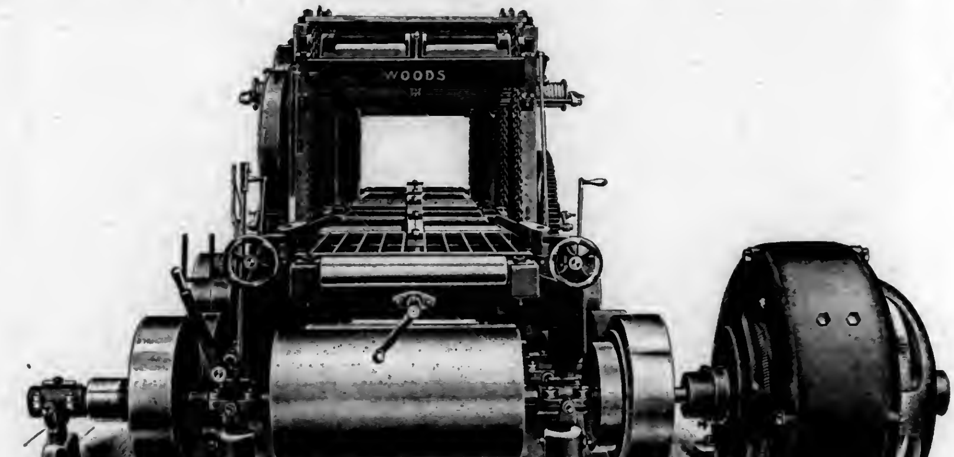
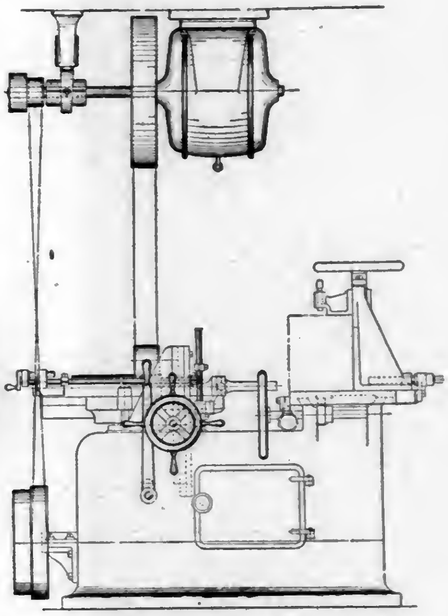


DIRECT-CONNECTED INDIVIDUAL DRIVE UPON A RAILWAY CUT-OFF SAW.—S. A WOODS MACHINE CO.



DIRECT-CONNECTED INDIVIDUAL DRIVE UPON A HEAVY PLANER AND MATCHER.
S. A. WOODS MACHINE COMPANY.



BELTED INDIVIDUAL DRIVE UPON A WOODS HORIZONTAL MORTISER.

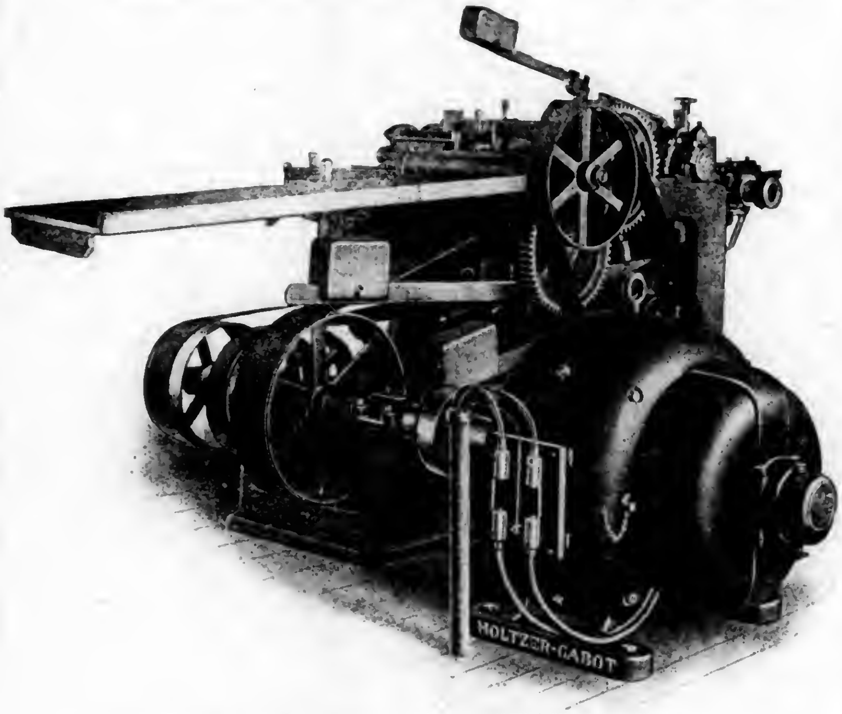
WOODWORKING MACHINERY.

IMPORTANT DEVELOPMENTS IN INDIVIDUAL DRIVING BY ELECTRIC MOTORS.

The principle of driving wood-working machines either individually or in groups by electric motors has come to be regarded as a necessary feature of the equipment of every modern wood-working establishment, whether in a railroad shop or elsewhere. The importance of the electrical system transmission of power is being realized, and during the last few years both builders and users have given the subject special consideration.

As our readers are doubtless aware, the advantages to be gained from the electric power transmission and driving are numerous, but the most important may be treated under the following heads: First, saving of power; second, decreased cost of maintenance; third, increased output, and, fourth, convenience and flexibility.

The saving of power through the direct driving of wood-working tools by electricity is a matter of the highest importance. Tests have brought to light instances where five-sixths of the power developed in the ordinary engine room was dissipated in the shafting and belting, this with every machine running at full load, a condition seldom reached in practice, and the maximum of efficiency of the plant proved to be only 30 per cent. This is an abnormal case, however, and is the exception rather than the rule.



DIRECT-CONNECTED INDIVIDUAL DRIVE UPON AN OUTSIDE MOULDER BUILT BY THE S. A. WOODS MACHINE COMPANY.

The quantity of power required to drive wood-working machinery varies enormously according to the character and quality of the lumber worked, the speed of feed, the depth of cut and more particularly the *condition of the knives, teeth and other cutting edges.* The importance of keeping the cutting edges in good order will be apparent when it is understood that a given amount of work, on either green or dry lumber, may easily require an expenditure of 300 per cent. more power when the knives or cutters are dull than when they are sharp. Again, the power required by the machine itself is very much greater than that required by a metal-working tool of corresponding size, and when this large amount of power is to be transmitted through considerable belting and long runs of shafting, the losses in transmission are great.

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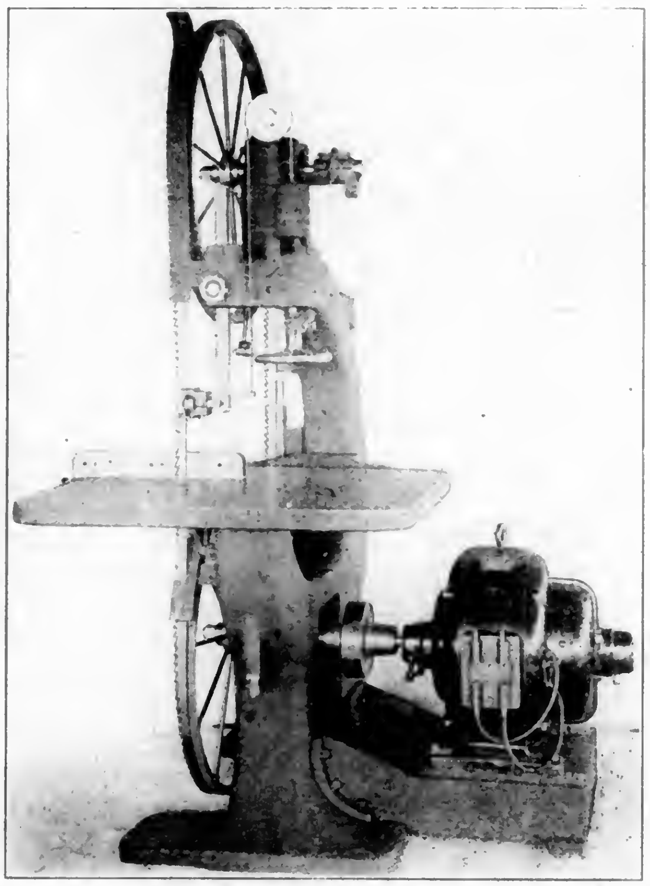

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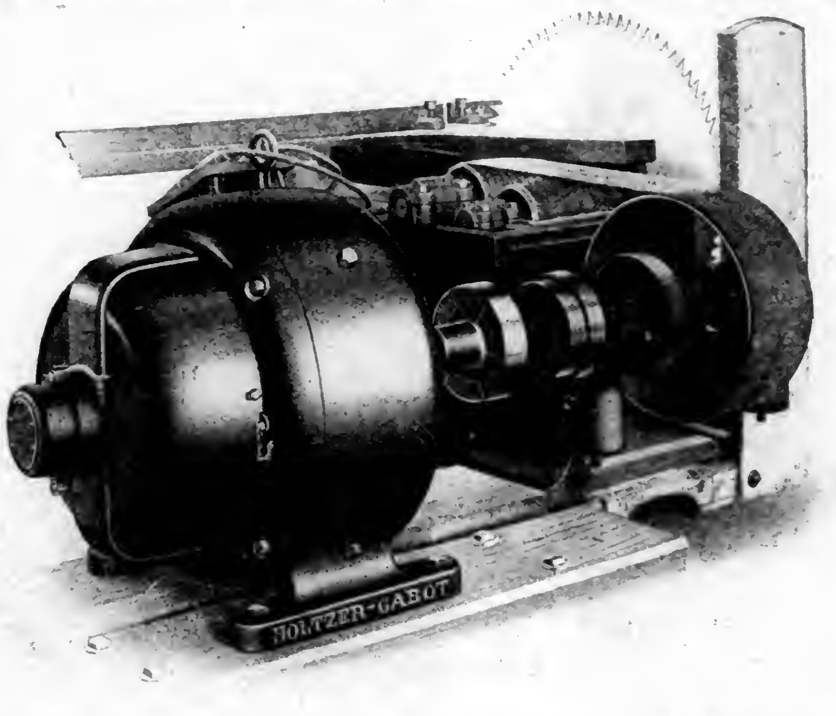

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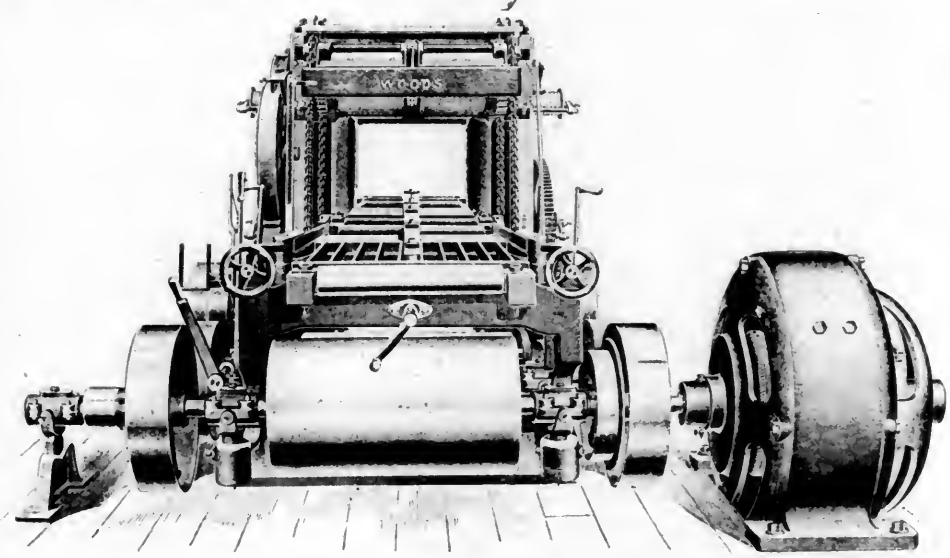

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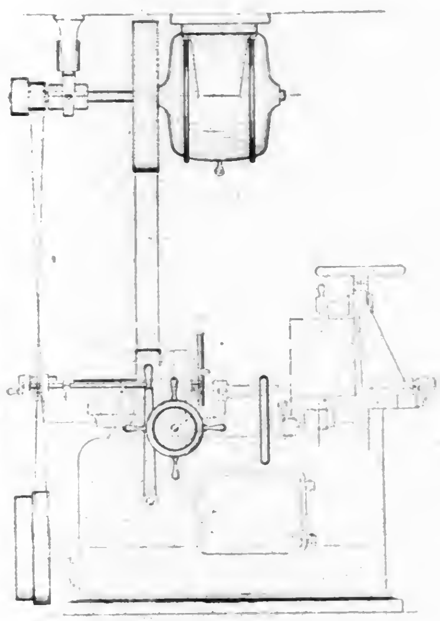

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matchers generally, and, as stated earlier in this article, the result depends largely upon the condition of the cutting tools, perfect conditions requiring much less power than would ordinarily be estimated.

A large number of the tools built by this company are now being operated by electricity and those most commonly used may be approximately estimated for power as below:

24 and 20-in. heavy timber sizer or car-sill dresser, from	45 to 60 h. p.
8 and 15-in. planer and matcher, from	20 to 35 h. p.
24 and 30-in. planer and matcher, up to	45 h. p.
36 by 6-in. cabinet planer (single surfacer)	10 to 15 h. p.
13 by 6-in. triple column outside moulder	20 h. p.
16-in. self-feed saw table	15 to 25 h. p.
14 by 16-in. automatic railway cut-off saw	15 to 20 h. p.
30 to 42-in. automatic knife grinder	2 h. p.
1½ to 2 sq. in. hollow-chisel mortiser	15 h. p.
5-16 to 1½ sq. in. hollow-chisel mortiser	10 h. p.
Multiple-spindle boring machines require from	6 to 8 h. p.
Automatic car gainers about	15 h. p.

These figures represent the maximum requirements under the usual mill conditions and cover the momentary loads, although, as before stated, with perfect conditions the power could be reduced considerably. We know of cases where some of the machines enumerated above are being operated with motors considerably smaller than we have recommended. This is perhaps due, as we have stated before, to the existing conditions at the various plants. It must be borne in mind that these amounts are estimated from their knowledge of average mill conditions. These builders are prepared to furnish all their machines for direct motor driving.

THE STEAM TURBINE FROM AN OPERATING STANDPOINT.

By F. A. Waldron.

From a paper read before the American Society of Mechanical Engineers.

The steam turbine which this paper will describe is installed at the works of the Yale & Towne Manufacturing Company, Stamford, Conn., and is the first one of its size (outside of those operated by the builders) to be put into practical operation in this country. It is the writer's intention, therefore, to give not only an account of its installation and operation, but also data from the boiler-room to a brake horse-power delivered from the driving pulley of the motor.

After a thorough investigation by the writer, in the early part of 1901, it was decided to install a Westinghouse-Parsons steam turbine, for the following reasons: (1) Floor space, (2) economy, (3) continuous operation of existing plant during installation of the new. The problem was, therefore, to concentrate the largest amount of power in the smallest possible area consistent with economical operation.

The generating outfit consists of a two-phase, 240-volt alternator of 400-kw. capacity (when the turbine was running condensing, and the power factor of the alternator was from 90 to 100 per cent.), 7,200 alternations, running at 3,600 r. p. m., with a separate direct-connected exciter set. The alternator is of the revolving field type, and the surface speed of the field is 22,137 ft. per minute. The weight of the outfit is 33,200 lbs., and it occupies a floor space 19 by 4½ ft. The guaranteed economy was 16½ lbs. of water per electrical horse-power at the switchboard, with 28 ins. of vacuum, 40 degs. Fahr. superheat, and 155 lbs. gauge pressure.

Sixty-four induction motors (with varying loads), ranging from ½ to 40 horse-power, are distributed throughout the works. With the exception of the elevator motors, the entire plant is arranged on the group system. Wherever one or more machines are to be driven, belting or gearing is used, and if room will permit, belting is given the preference.

The turbine end of this machine has received very little attention in the past year, and has required no renewals or repairs to any of its parts; in fact, from an operating standpoint, it is almost foolproof. Occasional longitudinal adjustment, to check the clearance between the blades in the case and the revolving element, is necessary. The wear and tear on other parts of the machine have been practically *nil*, and if the oil is kept in constant circulation and properly cooled, there is no need of a "hot box," and the amount of oil used is extremely small, the consumption of this particular machine being ½ gal. of cylinder oil per week, and from 3 to 5 per cent. of the lubricating oil on the bearings may be said to be wasted. The principal trouble with the steam end is its liability to shut down, when running from three-quarters to full load, because the vacuum is destroyed. This can be prevented if the engineer is on hand, but sometimes he isn't there, and we have had one or two shut-downs in the last year from this cause. I am informed, however, that a device for automatically preventing this is being designed by the makers, and we expect to have it on our second machine.

The electrical end of the machine has given us *all* the trouble—not from the result of electrical design and defect, but from mechanical defects, pure and simple. The field or revolving element is made of four cylindrical forgings, 23⅜ ins. in diameter, aggregating in length about 28 ins. These sections are forced onto a shaft with about 150 tons pressure. Owing to centrifugal force and the heat developed in the field, one of these sections crept on the shaft about ¾ in., the result being that on August 21, 1902, one of the field wires was pulled apart. Repairs were quickly made, and the makers agreed to furnish us a new field, which was placed in position the latter part of December; when, upon starting the machine for the purpose of testing, it immediately (upon attaining full speed, and without any load upon it) flew into a large number of pieces, entirely demolishing the electrical end and badly damaging the steam end. Investigation showed that invisible flaws in the forging were the cause of this accident.

A memorandum has been kept by the author of all of the questions which had been asked him in regard to this installation, and as a matter of record he would like to place the more important ones before the society, in the order of their importance:

Does it fulfill the guaranteed economy? [The tables show that its performance is satisfactory.—Ed.]

Are you satisfied with the continuity of operation? Outside of the breakdown (which was due to defective material, or to causes entirely foreign to the machine), it is entirely satisfactory.

What condensing outfit is necessary? This is a question which each purchaser can best decide for himself. The writer's experience, however, is that the best is none too good, and that for continuous running and high vacuums the dry system, with a two-stage air pump, will probably maintain higher average vacuums than any other system.

Can exhaust steam be used for heating? This turbine has supplied 25,000 sq. ft. of direct radiating surface and 7,500 sq. ft. of blower-stack surface, and maintained a temperature of from 60 to 70 degs. Fahr. in all buildings when generating 520 kw, and with a temperature of 220 degs. Fahr. in the exhaust chamber of the turbine.

What overload will it stand? A 50 per cent. overload has been maintained at full speed for five hours without apparent injury to the machine.

Can it be changed from condensing to non-condensing and vice

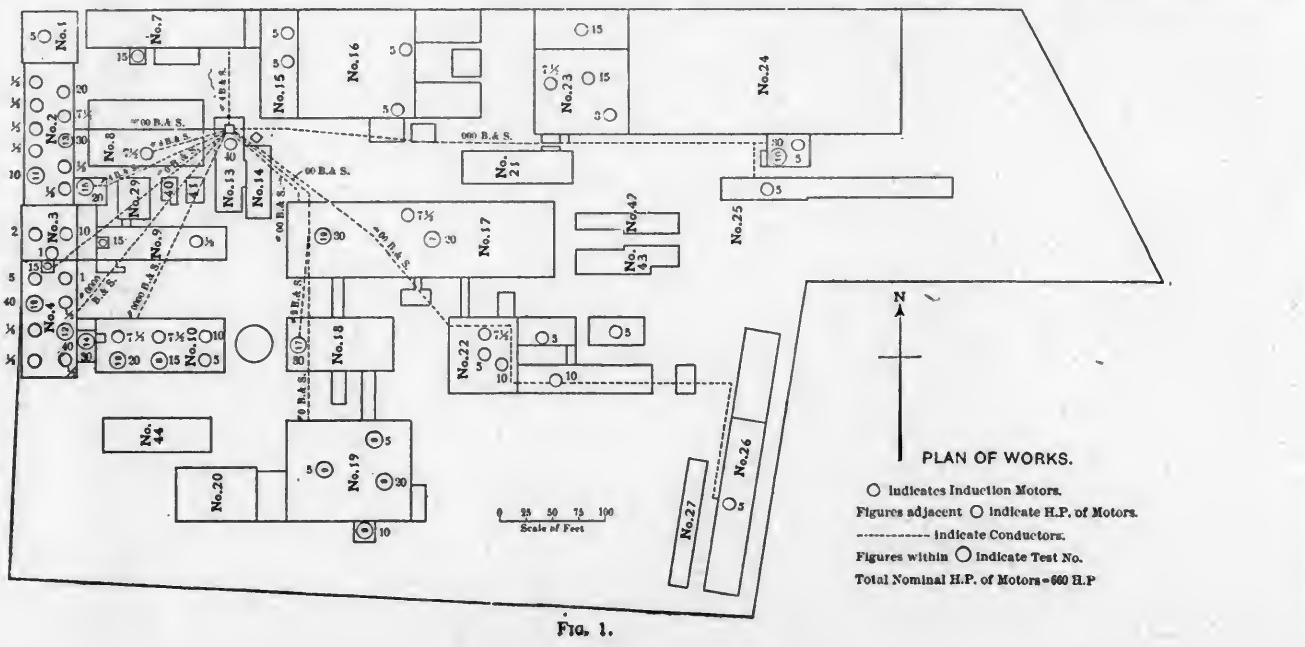


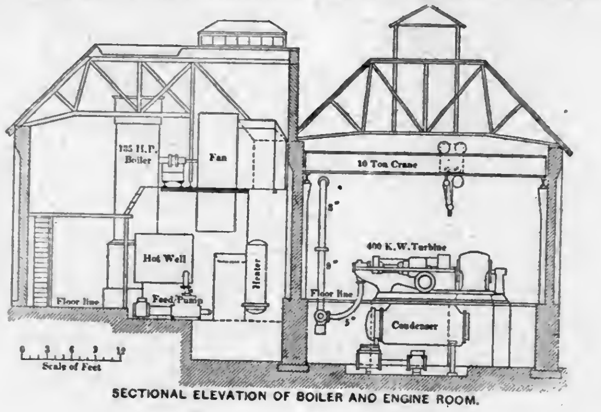
Fig. 1.

rsa, when running? This we have done daily, during the heating riod, and without difficulty or shut-down.

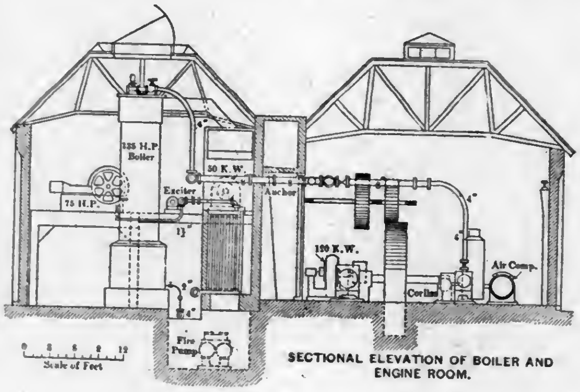
Type of exciter? The exciter should be driven by an independent gine.

Is your confidence in the machine shaken after the trouble you ve had with it? The best reply to this is that a second outfit s been ordered.

Cost? Upon the basis of strictly competitive prices, the turbine, ady to run, costs from 10 to 15 per cent. less than the same sized ciprocating engine outfit. The cost of the power-house, per uare foot, per kilowatt, would be about 65 per cent. less for a



SECTIONAL ELEVATION OF BOILER AND ENGINE ROOM.



SECTIONAL ELEVATION OF BOILER AND ENGINE ROOM.

chinery when running idle; (c) the total power used by the shafting, machinery and useful work; (d) efficiency of electric transmission.

The tests were made under actual running conditions, the test for each room being continued for one-half day, with regular working load, and readings of the watt meter were taken every two minutes. The mean vibration of the pointer was taken as the true reading. The efficiency of the motors (under their different loads) was taken from the curves furnished by the builders. The analysis of these tests would indicate that, with the turbo-generator driving induction motors, and with an evaporation of 8.707 lbs. of water per pound of coal, a brake horse-power can be delivered from the pulley of the motor for about 2½ lbs. of coal with a turbine of this size running under average economy. (This allows 5 per cent. for banking.) Under the same evaporative conditions the average non-condensing engines distributed through the different rooms in the plant would require 7.5 lbs. of coal per brake horse-power at the fly-wheel, or three times that quantity required for the electrical drive.

In conclusion, the results obtained from this outfit may not be any higher than many obtained by direct-connected sets of the same size running under maximum economical conditions. Assuming, however, that they are the same, the advantages of initial investment, constant economy and the possible extension of the plant with the turbo-generator outfit, are of sufficient importance to warrant the installation. The strongest appeal, however, that the turbo-generator makes to the business man or the engineer is its inherent commercial efficiency. By this I mean that its efficiency is unchanged week in and week out, year in and year out. Leaky pistons or valves, lack of alignment of slides and bearings, keying up, and, above all, lubrication, all of which exist in the reciprocating engine, are eliminated in the turbine.

[EDITOR'S NOTE.—This is an important and excellent paper. It presents illustrations and records of the performance, including boilers, turbines, generators and motors. We reproduce the motor tests, and recommend the reader to secure a complete copy of the paper.]

ALTERNATING CURRENT MOTORS FOR VARIABLE SPEED.

A Paper Read Before the American Society of Mechanical Engineers.

BY W. I. SLICHTER.

The impression is very general that a variable speed cannot be obtained with an alternating current motor, and that if an alternating current plant is to be installed, the idea of obtaining a variable speed drive of any of the tools must be abandoned. This is not so, and the object of this paper is to show the possibilities of this type of motor and to point out its limitations. But it must be understood in the first place that it is not claimed for the alternating current motor that it can compete with the direct cur-

TABULATION OF MOTOR TESTS.

DATA. Number of Test.	Location. Building.	Location. Room.	Location. Kind of work.	Conductor. Size B. & S. gauge.	Conductor. Length of line per Phase in feet.	Energy at switchboard A. K. W.	Energy at switchboard A. H. P.	Average Motor Load. Input B. K. W.	Input B. H. P.	Output C. K. W.	Output C. H. P.	Nominal Rating of Motor in H. P.	Transmission Losses. Electrical. Line loss D=A−B. K. W.	Line loss H. P.	Motor loss E=B−C. K. W.	Motor loss H. P.	Mechanical. Shafting F. K. W.	Shafting F. H. P.	Shafting and Machines Idle, G. K. W.	Shafting and Machines Idle, G. H. P.	Efficiencies. %. Line (a) = B/A	Motor (Commercial) (b) = C/B	Electrical* (c) = C/A	Water rate per hour at Motor Pulley. Per K. W.	Water Per H. P.	Coal rate per hour at Motor Pulley. Per K. W.	Coal Per H. P.	Combustible rate per hour at Motor Pulley. Per K. W.	Combustible Per H. P.	Horse-power required per foot of shafting.
7	17	Rod shop	Automatic screw machinery	No. 00 " 4	250 300	34.4	46.1	33.2	44.5	26.85	36.	27.5	1.2	1.6	6.35	8.5	12.9	17.3	21.6	29.	96.3	81.	78.	28.6	21.3	3.28	2.45	2.72	2.03	.029
8	10	105	Gen'l machining.	" 0000 " 6	520 150	13.35	17.9	13.	17.43	11.05	14.8	15.	.35	.47	1.95	2.6	5.6	7.5	16.4	22.	97.6	85.	82.8	27	20.2	3.09	2.31	2.57	1.92	.029
9	19	Cabinet lock shop	Gen'l machining, polish'g & buff'g	" 00 " 0	250 700	36.	48.8	34.5	46.3	28.5	38.2	40.	1.5	2.	6.	8.1	....	....	23.5	31.6	95.8	82.5	79.	28.3	21.1	3.24	2.42	2.68	2.00	.041
10	24	Iron Foundry	Cupola blower & heating system.	" 000	1,400	31.2	41 8	30.	40.2	24.85	33.3	30.	.8	1.07	5.15	6.9	....	....	2.4	3.22	96.2	83.	80.	27.9	20.8	3.2	2.39	2.66	1.98	
11	2	25..	Plating dynamos and exciter.....	" 00 " 6	390 270	5.14	6.89	5.	6.7	4.05	5.43	10.	.14	.19	.95	1.27	..	....	.93	1.25	97.3	81.	79.	28.3	21.1	3.24	2.42	2.68	2.00	
12	4	44	Polishing and baffling	" 0000 " 0	500 120	33.1	44.4	32.5	43.6	28.2	37.6	40.	.6	.8	4.3	5.8	21.1	28.3	22.7	30.5	98.2	87.	85.2	26.2	19.5	3.01	2.24	2.49	1.86	.091
13	2	24............	Polishing and baffling........	" 00 " 2	390 100	27.2	36.4	26.5	35.5	22.55	30.2	30.	.7	.94	3 95	5.3	12.3	16.5	17.9	24.	97.6	85.	83.	26.8	20	3.08	2.3	2.56	1.91	.063
14	4	44............	Ventilating system	" 0000 " 2	400 200	26.42	35.4	25.7	34.4	20.7	27.7	30.	.72	.96	5.	6.7	....	....	......	......	97.5	80.5	78.4	28.5	21.3	3.27	2.44	2.71	2.02	
15	2	24....	Ventilating system.	" 4	350	27.2	36.56	26.56	35.7	21.36	28.7	20.	.64	.86	5.2	7.	....	...	......	......	97.7	80.5	78.7	28.4	21.2	3.26	2.43	2.7	2.02	
16	10	101............	Heating system..	" 0000 " 4 " 8	520 80 240	25.6	34.7	24.4	32.8	19.9	26.75	20.	1.4	1.9	4.5	6.05	....	....	......	......	94.8	81.5	77.2	28.9	21.6	3.32	2.47	2.75	2.05	
17	18	Smith shop	Drop forging.....	" 00 " 0 " 2	250 100 300	18.47	24.8	18.1	24.3	15.65	21.	30.	.37	.5	2.45	3.3	....	....	15.	20.1	97.8	86.5	84.5	26.4	19.7	3.03	2.26	2.52	1.88	
18	4	45.............	Plating dynamos.	" 0000 " 0	500 140	22.3	29.9	22.	29.5	19.	25.5	40.	.3	.4	3.	4.	....	...	5.6	7.5	98.6	86.5	85.2	26.2	19.5	3.01	2 24	2.49	1.86	
19	17	Tool, mach., & press shop.	Tool making and press work.....	" 00	310	36.	48.25	35.6	47.7	28.8	38.6	30.	4	.55	6.8	9.1	14.9	20.	33.5	45.	98.5	81.	80.	27.9	20.8	3.2	2.39	2.66	1.98	.026
																							Ave ..	27 65	20.62	3.17	2 37	2.63	1.96	

* Ratio of energy delivered at motor pulley to energy at switchboard.

THE STEAM TURBINE FROM AN OPERATING STANDPOINT.

turbo-generator outfit than for a reciprocating engine of the same power and economy. The cost of foundations is taken into account in the cost of the engine and turbine. The cost of piping is not included in either case, excepting the piping between the throttle and the condenser.

Is the vibration excessive? The author considers that, unless it is possible to balance a lead pencil on the outboard bearing and allow it to remain there for a minute, the machine is vibrating more than it should; and while there are no foundation bolts to hold the machine down, there has been no tendency for it to creep on its foundations.

The principal points brought out by the tests are: (a) Difference in frictional losses, depending on speed and arrangements of shafting in the different rooms; (b) the power utilized by the ma-

rent type where continual variations of speed throughout a wide range are required, as the latter motor is usually superior in efficiency under these conditions.

Let us assume, then, that the problem to be solved is a case where an alternating current plant is desirable for general reasons, such as distance of transmission or availability of power, and that a considerable amount of the power is used in constant speed work, but a certain portion of the work requires a variable speed. What is the most appropriate and most efficient method of obtaining the variable speed?

The speed of an alternating current motor may be controlled in a number of ways:

(a) By varying the potential applied to the primary of a motor having a suitable resistance in the secondary; (b) by varying the

resistance in the secondary circuit; (c) by changing the connections of the primary in a manner to change the number of poles; (d) by varying the frequency of the applied voltage.

For the benefit of those not familiar with the polyphase induction motor, a general view of its characteristics may be desirable.

These characteristics are very similar to those of the continuous current shunt motor—that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about 15 to 20 per cent. below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects. The one exception to this last rule is the effect of the resistance (or losses) in the secondary (usually the rotating) member.

The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops. These characteristics are equally true for the 2-phase or 3-phase motor, of course, as the two motors are practically identical in their construction.

In this connection it should be remembered that a variation of an alternating voltage may be obtained by means of a reactance or compensator with a very small loss of energy, whereas with a continuous voltage the loss of energy is usually proportional to the variation in voltage.

Potential Control.—In this a suitable reactance or "compensator" reduces the line voltage to the fractional value desired. In this reduction the energy lost is only about 5 per cent. of the amount transformed.

The induction motor should have a very large resistance in the secondary, which is preferably of the squirrel cage type. This resistance gives the motor a speed characteristic such that its full load speed is some 10 per cent. less than that of a normal motor, and as the load is increased, the speed will fall to about 30 per cent. of this value without the motor "breaking down" or falling out of step, which in the normal motor usually takes place at about 80 per cent. of the full load speed.

Such a motor would have the following characteristics, assuming its synchronous speed as 1.00, and the voltage applied as 100. (This is based on a 50-h.p., 40-cycle motor, at 800 revolutions per minute, as an instance.)

For constant full load (50-h.p.) torque at various speeds:

	Speed.	Volts.	Efficiency.	Losses, Motor.	K.W. Comp.
Full load speed	.89	100	81	8.8 K.W.	0.0 K.W.
Three-quarter load speed	.67	66	59	18.5 K.W.	1.0 K.W.
One-half load speed	.45	57	37	32.0 K.W.	2.0 K.W.
One-quarter load speed	.22	56	17	45.7 K.W.	3.5 K.W.
Normal motor (full speed)	.98	100	88	5.0 K.W.	0.0 K.W.

From this we see the principal and worst characteristic of this scheme. The increased losses in the motor (thus increased heating) with the decreased speed. This means that the motor must be larger than normal.

Rheostat Control.—In this scheme the secondary or rotor must have a definite winding (as opposed to the squirrel cage, which is cheaper) with slip rings and brushes to lead out the current. The friction and resistance losses due to these brushes decrease the efficiency of the motor somewhat. The secondary is usually wound for a higher voltage and less current than in the standard or normal motor, to minimize these losses. The action of this method is based on the principle that, in an induction motor, the drop in speed for any given torque is proportional to the resistance of the secondary circuit.

This scheme would show the following characteristics for the same motor as before at 50-h.p. torque, constant:

	Speed.	Volts.	Eff.	Losses. Motor.	Rheo.
Full load speed	.96	100	86	5 K.W.	0.0 K.W.
Three-quarter load speed	.72	100	65	5 K.W.	9.0 K.W.
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As will be seen, this method gives a higher efficiency throughout, but particularly excels the previous method in having so much smaller losses in the motor itself, thus permitting of a smaller design and less danger of damage. The losses are concentrated in a rheostat, which is a cheaper piece of apparatus and less liable to damage, being of iron and asbestos usually, instead of high grade insulating materials, as in the motor proper.

Changeable Poles.—By using a pitch of winding which is commensurable with two numbers of poles, we may build a motor which will operate with either 4 or 8, 6 or 12, etc., poles, by a slight change of the connections. Or by a more intricate arrangement of windings a change from 4 to 6, 6 to 8, etc., may be made. In this arrangement it is necessary to use a squirrel cage armature, since it is suitable for any number of poles, and the pitch of the primary coils has to be made some compromise value between the normal pitch of the two combinations, so it is usually not the best or most effective pitch for either number of poles. Therefore the constants of this motor should not be expected to be as good as those of the standard motor. Of course such a motor operates advantageously only at two speeds corresponding to the synchronous speeds of the two arrangements. Thus, a 12 and 6-pole motor at 40 cycles would operate at either 400 or 800 revolutions respectively. If a wider range is desired, the potential control scheme first mentioned may be combined with it.

For a motor operating at full and half speeds, say with 6 and 12 poles for 800 and 400 revolutions, we would have:

	Volts.	Eff.	Losses.
Full speed, 50 h.p.	100	86	5.8
Half speed, 25 h.p.	100	74	6.6

Thus, for full load torque at half speed we get an efficiency almost double that obtained with the other methods, but what losses there are are in the motor itself, as in the first case. The losses are about the same in the two cases, the speed thus the ventilation being half in one case, the heating is greater at the lower speed.

Variable Frequency.—Every induction motor tends to run at synchronous speed—that is, at a speed equal to $\frac{60 \times \text{frequency.}}{\frac{\text{Poles}}{2}}$

Thus, if a different frequency is impressed on the motor, it will run at a different speed. Some installations have been made where two or three alternating current generators are used to obtain different frequencies, and these circuits are carried around the shops by various sets of lines (usually three in each set) and the motor connected to the lines giving the frequency and speed desired. For normal losses in the iron the voltage must vary with the frequency. Thus for full and half speed we have:

	Volts.	Eff.	Losses.
Full speed, 50 h.p.	100	88	5
Half speed, 25 h.p.	50	87	2.8

Generators have been built having two stationary armatures in the same frame and two revolving fields, with a different number of poles on the same shaft to give the multiple frequency desired. An application of this principle, which is very pretty theoretically, is that of a very small variable speed induction motor (whose losses are negligible) which drives a commutator feeding the primary of the load machine; by a suitable control of the little motor any desired frequency may be supplied to the load machine from zero to full value, thus it may be started and run at any desired speed. A variation of this is to attach the commutator to the shaft of the load machine and the brushes to the shaft of the controlling motor, thus when the load machine is standing still the brushes revolve at almost full speed on the commutator, and a very low frequency is obtained in the commutated circuit. As the load machine speeds up, the difference in the speeds of the commutator and the brushes decreases, and hence the frequency increases until that time when the commutator and brushes are revolving together at the same speed when there is no commutation and the load machine receives full frequency.

SUMMARY.

From these descriptions it will be seen that the changeable pole and variable frequency methods are the most efficient, but do not permit of a variation through a wide range of speed. The rheostatic control is the simplest and easiest of control, giving a range from standstill to full speed, but is not as efficient as the first two, although more efficient than potential control. The last mentioned has the disadvantages of low efficiency and considerably increased heating in the motor itself, and is also unstable at low speeds, say below one-third speed. That is, a small variation in torque or a smaller variation in voltage will cause a considerable variation in speed.

The potential control is used where moderate variations in speed are wanted, not reaching to less than half speed for instance, and where the load is intermittent, not giving the motor a chance to get too hot. Its great disadvantage is the amount of current it takes at starting, which causes considerable disturbance in the supply circuit, flickering of lights, etc., due to the drop in voltage. The motor used is a cheaper one to build (for the same size) than the others, but if anything like continuous running is desired, the motor must be larger, thus much of this advantage is lost.

One advantage of this motor is that it may be totally enclosed for use in powder mills, oil refineries or where much dust or corrosive vapor is encountered, as it may be controlled from a distance without increasing the number of wires.

The rheostatic method is particularly adapted where frequent starting and low speeds are required, as it causes no unusual drain on the supply system when starting. Thus it is used for hoists, elevators, etc.

The changeable pole system has the same disadvantages in starting as the potential control. For long-continued running at only two different speeds it is excellent, and has constants comparable with those of a continuous current motor.

To vary the frequency of alternation for the motor requires an increased investment in generating station or auxiliary apparatus and line copper, and the greater the number of speeds desired, the greater this complication; but in its action and economy it is equal to any.

One point which is important to bring out is that with the changeable pole and changeable frequency systems the motor will not vary appreciably from the set speed for changes of load, while with either potential or rheostatic control, a change of load will cause an appreciable variation from the desired speed, requiring a readjustment of the potential or resistance to bring the speed to the desired value again.

An excellent illustration of the reliability of the induction motor was recently presented in a large plant using the 3-phase alternating-current system of power distribution. One of their induction motors is located at the foot of a fine-coal storage bin and works constantly in an atmosphere charged with coal dust. The motor has frequently worked without interruption while almost entirely embedded in accumulations of fine coal, and when it is cleaned out periodically a large quantity of coal is always taken out of it. It works constantly and with no attention except occasional greasing. The motor in question is one of the well-known type "C" 3-phase motors made by the Westinghouse Company.

TRACTION INCREASER AND WEIGHTS ON DRIVERS.

NEW YORK CENTRAL 4-4-2 TYPE LOCOMOTIVE.

The actual weights on drivers and trucks of the 4-4-0 type passenger locomotive of tne New York Central have been obtained in order to answer an inquiry for the exact figures. This engine was illustrated and described in this journal in February, 1901, page 35. The figures are as follows:

	Lbs.
Weight on drivers, working order, normal	94,800
Weight on drivers, working order, with traction increaser in service	104,800
Weight on forward truck, working order, normal	42,600
Weight on forward truck, working order, with traction increaser in service	37,000
Weight on rear truck, working order, normal	38,600
Weight on rear truck, working order, with traction increaser in service	34,200
Total weight of engine, working order	176,000
Weight of tender, loaded	114,000
Weight of tender, empty	50,800

"The worst fault I have to find in most all tools is that they are short of power. As a rule, the belt speed is too slow, and the gearing is too weak. If you take almost any tool and adapt it for electric driving, where there is no slip of the belt, you will find that it is only a question of time before the gearing begins to give trouble and ultimately breaks down. Almost every tool I have bought is defective in this detail, and could have easily been improved with a little forethought and at very little expense. In this respect my experience has been shared by most of my friends. A few days ago I was looking through one of the most up-to-date shops in this district, and the same lamentation was there, viz., want of power. The tools would not do what they were led to expect, and all sorts of excuses were made by their makers.

"All large machines that have heavy parts that require to be moved should be fitted with a power motion to such parts. Except in a few cases, the quick 'hand transverse' should be done away with, and quick 'power transverse' should be substituted. All radial drills should have a proper power motion for raising and lowering the arm—something a little better and quicker than putting on and taking off a belt."—A Large User of Machine Tools.

The annoyance of troublesome vibrations set up by a steam engine resting on a concrete foundation resting on a thick bed of clay, with rock underlying, were suppressed in the following manner, according to the *Iron Age:* The engine was removed and shafts 4 ft. in diameter were sunk into the subsoil for a distance of 30 or 40 ft. At the bottom of the shafts enlargements were made and concrete foundations put in. Cast iron pipes, 30 ins. in diameter, in 12-ft. lengths, were reared on these foundations to the under side of the engine bed. The pipes were then filled solid inside with Portland cement concrete, and sand packed around the outside of the pipes, filling up the shafts. The engine bed was relocated and wholly supported in this way, isolated from the surface soil.

The Gisholt Machine Company, Madison, Wis., has recently amended its articles of incorporation, increasing its capital to $750,000. This company has confined itself almost exclusively to the manufacture of the now well-known "Gisholt" lathe. These tools are made in several varieties and sizes, and the line is being constantly extended. Increased demands have necessitated a considerable addition to the manufacturing facilities, both in buildings and equipment. These will double the former capacity. A large portion of the new additions will be used in producing the "Gisholt" lathe, and part will be devoted to the manufacture of other types of machine tools, such as boring mills, etc. These new machines, however, will not be undertaken until the completion of the buildings. Among other new facilities, contracts have been let for a large new foundry with the best up-to-date equipment. Fireproof construction will be employed in all of the buildings.

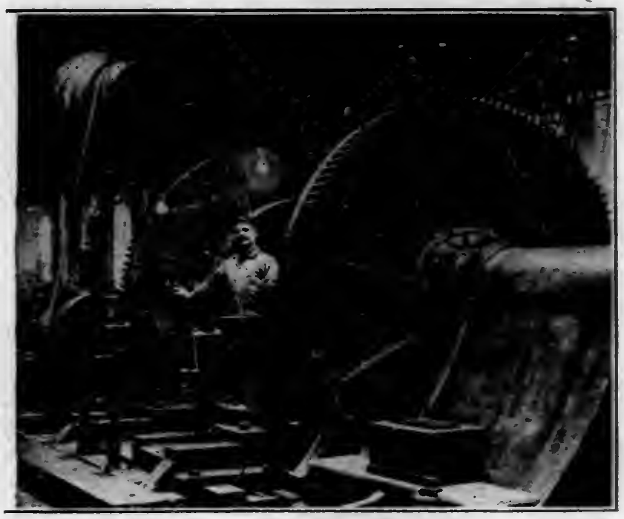
100-INCH DRIVING-WHEEL LATHE.

WEST MILWAUKEE SHOPS.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

In referring to the large motor-driven Bement-Miles wheel lathe at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railway on page 195 of our May, 1903, issue, we were inadvertently in error in stating that the motor used for the drive was a General Electric motor; we take pleasure in stating that this motor was built by the Milwaukee Electric Company, Milwaukee, Wis.

We are informed that this driving-wheel lathe, the photograph of which is reproduced herewith for reference, has made a remarkable record in operation. This tool is one of the heaviest driving-wheel lathes ever built, having a capacity for turning tires up to 100 ins. in diameter. The size of the lathe may best be judged from the fact that it weighs, exclusive of the motor, 112,000 lbs. The motor is one of the standard 20-h.p. direct-current machines built by the Milwaukee Electric Company. It is equipped for a 30 per cent. speed



100-IN. DRIVING-WHEEL LATHE.
CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

range by field control, the normal field speed being 650 revolutions per minute and the maximum 850 revolutions per minute.

The interesting test was made upon this lathe last spring. A pair of 84-in. tires were turned simultaneously with an average depth of cut at each tool of 5-16 in. and a feed of 3-16 in. The cutting speed was 18½ ft. per minute. The average horse-power required at the motor was 16½ h.p., but when cutting through hard spots on the tires the power required jumped up as high as 22½. Under this heavy duty the time required for the work was 63 minutes.

It is to be noted that the power required during this performance was very high, as the majority of motor-driven wheel lathes in use in this country are equipped with 7½-h.p. motors. We are pleased to learn also that the method of driving through cone pulleys, arranged with close centers and no adjustment for tightening the belt, is proving very satisfactory. We are indebted to Mr. F. M. Cox, formerly master mechanic of the above-mentioned shops and now superintendent of the Milwaukee Electric Company, for this correction and interesting information.

Mr. E. H. Symington, formerly connected with the T. H. Symington Company, of Baltimore, is now associated with the Railway Appliances Company, of Chicago, as manager of the Symington journal-box and dust-guard, the Railway Appliances Company being agents for the Chicago territory.

resistance in the secondary circuit; (c) by changing the connections of the primary in a manner to change the number of poles; (d) by varying the frequency of the applied voltage.

For the benefit of those not familiar with the polyphase induction motor, a general view of its characteristics may be desirable.

These characteristics are very similar to those of the continuous current shunt motor—that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about 15 to 20 per cent. below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects. The one exception to this last rule is the effect of the resistance (or losses) in the secondary (usually the rotating) member.

The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops. These characteristics are equally true for the 2-phase or 3-phase motor, of course, as the two motors are practically identical in their construction.

In this connection it should be remembered that a variation of an alternating voltage may be obtained by means of a reactance or compensator with a very small loss of energy, whereas with a continuous voltage the loss of energy is usually proportional to the variation in voltage.

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For constant full load (50-h.p.) torque at various speeds:

	Speed.	Volts.	Efficiency.	Losses, Motor.	K.W. Comp.
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One-half load speed.......	.45	57	37	32.0 K.W.	2.0 K.W.
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Normal motor (full speed).	.98	100	88	5.0 K.W.	0.0 K.W.

From this we see the principal and worst characteristic of this scheme. The increased losses in the motor (thus increased heating) with the decreased speed. This means that the motor must be larger than normal

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This scheme would show the following characteristics for the same motor as before at 50-h.p. torque, constant:

	Speed.	Volts.	Eff.	Losses. Motor.	Rheo.
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For a motor operating at full and half speeds, say with 6 and 12 poles for 800 and 400 revolutions, we would have:

	Volts.	Eff.	Losses.
Full speed, 50 h.p......................	100	86	5.8
Half speed, 25 h.p......................	100	74	6.6

Thus, for full load torque at half speed we get an efficiency almost double that obtained with the other methods, but what losses there are are in the motor itself, as in the first case. The losses are about the same in the two cases, the speed thus the ventilation being half in one case, the heating is greater at the lower speed.

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The changeable pole system has the same disadvantages in starting as the potential control. For long-continued running at only two different speeds it is excellent, and has constants comparable with those of a continuous current motor.

To vary the frequency of alternation for the motor requires an increased investment in generating station or auxiliary apparatus and line copper, and the greater the number of speeds desired, the greater this complication; but in its action and economy it is equal to any.

One point which is important to bring out is that with the changeable pole and changeable frequency systems the motor will not vary appreciably from the set speed for changes of load, while with either potential or rheostatic control, a change of load will cause an appreciable variation from the desired speed, requiring a readjustment of the potential or resistance to bring the speed to the desired value again.

An excellent illustration of the reliability of the induction motor was recently presented in a large plant using the 3-phase alternating-current system of power distribution. One of their induction motors is located at the foot of a fine-coal storage bin and works constantly in an atmosphere charged with coal dust. The motor has frequently worked without interruption while almost entirely embedded in accumulations of fine coal, and when it is cleaned out periodically a large quantity of coal is always taken out of it. It works constantly and with no attention except occasional greasing. The motor in question is one of the well-known type "C" 3-phase motors made by the Westinghouse Company.

TRACTION INCREASER AND WEIGHTS ON DRIVERS.

NEW YORK CENTRAL 4-4-2 TYPE LOCOMOTIVE.

The actual weights on drivers and trucks of the 4-4-0 type passenger locomotive of the New York Central have been obtained in order to answer an inquiry for the exact figures. This engine was illustrated and described in this journal in February, 1901, page 35. The figures are as follows:

	Lbs.
Weight on drivers, working order, normal	94,800
Weight on drivers, working order, with traction increaser in service	104,800
Weight on forward truck, working order, normal	42,600
Weight on forward truck, working order, with traction increaser in service	37,000
Weight on rear truck, working order, normal	38,600
Weight on rear truck, working order, with traction increaser in service	34,200
Total weight of engine, working order	176,000
Weight of tender, loaded	114,000
Weight of tender, empty	50,800

"The worst fault I have to find in most all tools is that they are short of power. As a rule, the belt speed is too slow, and the gearing is too weak. If you take almost any tool and adapt it for electric driving, where there is no slip of the belt, you will find that it is only a question of time before the gearing begins to give trouble and ultimately breaks down. Almost every tool I have bought is defective in this detail, and could have easily been improved with a little forethought and at very little expense. In this respect my experience has been shared by most of my friends. A few days ago I was looking through one of the most up-to-date shops in this district, and the same lamentation was there, viz., want of power. The tools would not do what they were led to expect, and all sorts of excuses were made by their makers.

"All large machines that have heavy parts that require to be moved should be fitted with a power motion to such parts. Except in a few cases, the quick 'hand transverse' should be done away with, and quick 'power transverse' should be substituted. All radial drills should have a proper power motion for raising and lowering the arm—something a little better and quicker than putting on and taking off a belt."—A Large User of Machine Tools.

The annoyance of troublesome vibrations set up by a steam engine resting on a concrete foundation resting on a thick bed of clay, with rock underlying, were suppressed in the following manner, according to the *Iron Age:* The engine was removed and shafts 4 ft. in diameter were sunk into the subsoil for a distance of 30 or 40 ft. At the bottom of the shafts enlargements were made and concrete foundations put in. Cast iron pipes, 30 ins. in diameter, in 12-ft. lengths, were reared on these foundations to the under side of the engine bed. The pipes were then filled solid inside with Portland cement concrete, and sand packed around the outside of the pipes, filling up the shafts. The engine bed was relocated and wholly supported in this way, isolated from the surface soil.

The Gisholt Machine Company, Madison, Wis., has recently amended its articles of incorporation, increasing its capital to $750,000. This company has confined itself almost exclusively to the manufacture of the now well-known "Gisholt" lathe. These tools are made in several varieties and sizes, and the line is being constantly extended. Increased demands have necessitated a considerable addition to the manufacturing facilities, both in buildings and equipment. These will double the former capacity. A large portion of the new additions will be used in producing the "Gisholt" lathe, and part will be devoted to the manufacture of other types of machine tools, such as boring mills, etc. These new machines, however, will not be undertaken until the completion of the buildings. Among other new facilities, contracts have been let for a large new foundry with the best up-to-date equipment. Fireproof construction will be employed in all of the buildings.

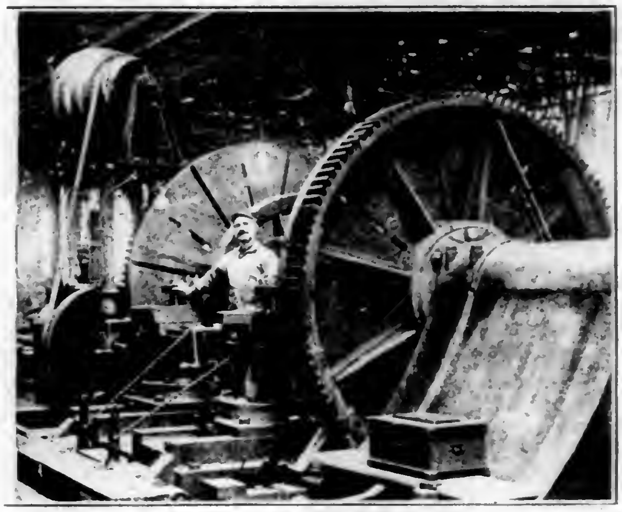
100-INCH DRIVING-WHEEL LATHE.

WEST MILWAUKEE SHOPS.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

In referring to the large motor-driven Bement-Miles wheel lathe at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railway on page 195 of our May, 1903, issue, we were inadvertently in error in stating that the motor used for the drive was a General Electric motor; we take pleasure in stating that this motor was built by the Milwaukee Electric Company, Milwaukee, Wis.

We are informed that this driving-wheel lathe, the photograph of which is reproduced herewith for reference, has made a remarkable record in operation. This tool is one of the heaviest driving-wheel lathes ever built, having a capacity for turning tires up to 100 ins. in diameter. The size of the lathe may best be judged from the fact that it weighs, exclusive of the motor, 112,000 lbs. The motor is one of the standard 20-h.p. direct-current machines built by the Milwaukee Electric Company. It is equipped for a 30 per cent. speed



100-IN. DRIVING-WHEEL LATHE.
CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

range by field control, the normal field speed being 650 revolutions per minute and the maximum 850 revolutions per minute.

The interesting test was made upon this lathe last spring. A pair of 84-in. tires were turned simultaneously with an average depth of cut at each tool of 5-16 in. and a feed of 3-16 in. The cutting speed was 18½ ft. per minute. The average horse-power required at the motor was 16½ h.p., but when cutting through hard spots on the tires the power required jumped up as high as 22½. Under this heavy duty the time required for the work was 63 minutes.

It is to be noted that the power required during this performance was very high, as the majority of motor-driven wheel lathes in use in this country are equipped with 7½-h.p. motors. We are pleased to learn also that the method of driving through cone pulleys, arranged with close centers and no adjustment for tightening the belt, is proving very satisfactory. We are indebted to Mr. F. M. Cox, formerly master mechanic of the above-mentioned shops and now superintendent of the Milwaukee Electric Company, for this correction and interesting information.

Mr. E. H. Symington, formerly connected with the T. H. Symington Company, of Baltimore, is now associated with the Railway Appliances Company, of Chicago, as manager of the Symington journal-box and dust-guard, the Railway Appliances Company being agents for the Chicago territory.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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THE METRIC SYSTEM.

At the conventions of the Master Mechanics' and Master Car Builders' associations the question of the metric system was handled promptly and decisively. There is no possible excuse for prolonged discussion on this subject at this time. Those who do not now know how they stand will never know and a lot of time has been lost by prolonged debates. It was well to vote and then pass on to other matters. The vote was almost unanimous in both associations and adverse to the proposed legislation looking toward the compulsory use of the system in the departments of the Government.

The metric system must eventually stand upon its merits. If it is good it will come into universal use. If it is not good it will not do so. Thus far experience seems to show that no existing system is sufficiently perfect to warrant universal adoption.

THREE CONVENTIONS AT SARATOGA.

Master Mechanics' Association.

With 97 new members, a new scholarship at the disposal of the association, a fund for scientific testing inaugurated by the Jerome Wheelock legacy and the locomotive tests at the St. Louis Exposition in prospect, this convention may be said to be an epoch-making one. Besides these important factors, the convention itself was most successful. The younger men are taking hold vigorously and the discussions took a new form. There was comparatively little of the old "experience meeting" about them, and often fundamental principles were touched, which means much to the future of the organization. For example, the discussion of the new tool steels developed the fact that an improvement of this kind induces others. The study of cuts, feeds and speeds brought out the far more important factor of time spent in getting ready to take cuts in the machines, a field for a vast amount of far-reaching improvement.

In the subject of electric driving of shops, two new principles were stated, and it is believed that they have not been stated before and that both are true, viz., that an improvement of 2½ per cent. in output will pay the cost of variable speeds on motor-driven tools and that if machine tools are furnished ready for motor attachment without additional cost it will cost no more for individual driving of tools costing $250 or more than for belting and countershafting. These statements will give food for thought to machine-tool builders, electric experts and shop managers. If not controverted they will exert a powerful influence on future practice.

Locomotive failures due to leaky tubes was unquestionably the most important subject concerning locomotive operation. This discussion was cut too short for lack of time, but the matter is in the hands of a strong committee empowered to secure data for next year. Mr. O. H. Reynolds called attention to the degree to which present practice has departed from the ideas of boiler proportions held by such men as D. K. Clark, and it is time the locomotive boiler should be studied and developed for the severe work it is called upon to perform. The discussion of this subject promises much for the future of American locomotives. It is necessary in some way to secure reserve boiler power to avoid working boilers "to death" in ordinary service. Something must be done to change the condition which makes it necessary for round houses to be full of boiler makers the country over.

An opportunity for which the railroad world has been waiting is offered by the decision of the Pennsylvania Railroad to include in its exhibit at the St. Louis Exposition the new locomotive testing plant. Under the direction of Mr. Willard A. Smith, chief of the transportation exhibits, the plant will be amply provided for and it will be kept busy with tests of American and foreign locomotives for the seven months of the exposition. The exhibit will be under the efficient charge of Mr. F. D. Casanave, formerly general superintendent of motive power of this road. The plans and even construction of the plant are now under way. The American Society of Mechanical Engineers will be represented in the tests by Prof. Goss, Mr. E. M. Herr and J. E. Sague. The Master Mechanics' Association by Messrs. F. H. Clark, H. H. Vaughan and C. H. Quereau. It is fitting that Prof. Goss should be permanent chairman of this joint committee, as he was the first to show the locomotive testing plant to be a success.

An additional scholarship placed at the disposal of the association was a feature of this convention. Messrs. Jos. T. Ryerson & Son, Chicago, have set a worthy example by providing a fund from which $600 will be available for four years to defray the expenses of a student at one of the technical schools. The candidate must be a graduate of a high school, an employee in a shop under the jurisdiction of a member of the Master Mechanics' Association, and he must be in good health. There is no restriction as to schools selected, and while there is no legal obligation to repay the money, it is to be understood as "a debt of honor, to be returned if circumstances permit." The donors express the hope that this may become the nucleus of a large fund to be made up of contributions from those who have been benefited. This generous action is worthy of the highest commendation.

This year and last have brought a new significance to the exhibits at the conventions. The exhibits reflect increasing efforts to follow the needs of the railroads and produce that which will meet the requirements. This has brought satisfactory response from the railroad men. The cursory examinations of former years do not now suffice. The larger roads now send a number of representatives. This is also noticed in connection with the large systems of roads. These men meet by appointment and make a thorough study of the exhibits, assembling afterwards for a conference to compare notes and review impressions. The writer was invited to

join three such groups and is sure that nothing on the grounds was missed. Until last year this sort of thing was not so noticeable. This tendency is encouraging. It is apparent that the convention exhibits bear a closer relation to the work of both of the associations than ever before, and that they are becoming increasingly important.

The sentiment generally expressed at Saratoga favors St. Louis as the place for the next convention. Already guarantees have been made for satisfactory accommodations and the exposition, with its unusual facilities for studying transportation exhibits, together with the locomotive testing plant, render it most desirable to hold the conventions there. It is to be hoped, however, that arrangements may be made to hold them in May or early in June and before the advent of the hottest weather; also that no pains will be spared to secure a suitable hall for the conventions and avoid the serious effect of the unsatisfactory hall this year at Saratoga.

Master Car Builders' Association.

While all three conventions were hurried by long programmes, this fault was most noticeable in this one. A number of topical discussions were left out, and their value to a large extent was lost. It would be a good plan to print the presentations of topical subjects for distribution with the advance copies of papers and reports. Their effect would not then be lost in case they are crowded out of the sessions.

This leads to a remark that the only discussion of steel cars this year was a topical one, and yet this is one of the most important problems before the association. A rather unfair impression may be derived from the discussion this year. Steel cars are not perfect, but several speakers expressed themselves in such a way as to give the impression that they are far from satisfactory. This is not the case, and those who use the largest number of steel cars said nothing of this kind. It is not claimed that all steel cars are satisfactory, but that careful design results in the best equipment ever built when steel or composite construction is used will not be questioned. An example in point is the remarkable series of composite cars on the Norfolk & Western, which has often been referred to in these columns. It must be remembered that while the earlier designs of steel cars were made by railroads, at present this matter is almost entirely in the hands of the manufacturers. That this subject is now treated only in a topical discussion is rather a reflection on the association. In fact, the M. C. B. Association, as an organization, cannot be said to have kept in the closest touch with steel cars. It may have been better to leave the problems to the manufacturers. The fact is that this has been the rule.

Just now an opportunity is presented for good work in steel frame design in connection with the standard car, and this is a problem which the association only can solve. Whatever individual opinions of the business question involved in steel frame construction may be, it must be admitted that on many roads it is justified and that a large number of such cars will be built. Therefore it seems necessary to provide for both wooden and steel-frame cars in the preparation of standard designs. Progress on the standard car must necessarily be made thoroughly and carefully, but if the fact is appreciated that this is the greatest opportunity of the association to-day the utmost possible progress will be made.

While many other subjects might be commented upon, only one more may be mentioned here—the movement toward 2-in. train lines for heating passenger cars. This marks a radical reconstruction of practice in steam heating of passenger trains and it will undoubtedly lead to the careful overhauling which has become necessary through the rapid advances in train operation, with which heating systems have not kept up. The manufacturers of this equipment are somewhat in advance of the railroads and the discussion this year promises a renewal of attention which has become necessary.

Space permits but a brief reference to the fact that the very large attendance and spirited interest in the subjects combined to make this a most successful convention.

American Society of Mechanical Engineers.

That the recent Saratoga meeting was successful was apparent to everyone in attendance. Arrangements for entertainment and excursions were admirable, the only regrettable feature being a hall near a busy railroad track and with poor acoustic properties. The programme was too long for adequate discussion of some papers, but if the members were prepared to present discussions in concise and time-saving form there would have been time for all.

The event of the meeting was the reception of an entirely new constitution, which had been prepared by a special committee, and was ordered submitted to letter ballot practically without discussion and without dissent. This was a remarkable achievement. The secret lay in the report itself, for which great credit is due Mr. C. W. Hunt, chairman of the committee, and also in the fact that every member had been given an opportunity to express to the committee his views of the preliminary draft before its final presentation.

At this meeting the results of a letter ballot to ascertain the views of the members on the subject of the metric system was announced. A total of 514 members voted, of whom 3 to 1 were opposed to the metric system and to any legislation in favor of its adoption. It is to be hoped that this action has effectually buried the metric system as far as this organization is concerned.

Discussion upon the paper by Mr. Blood on the subject of train resistance formulæ was not at all satisfactory. The author made clear the necessity for better formulæ, but the fact that a dynamometer car is really required for any important work was not clearly brought out.

Among the many subjects before this meeting, that of shop management was of transcendent importance. It was treated in three separate papers—"The Machine Shop Problem," by Charles Day; "A Graphical Daily Balance," by H. L. Gantt, and "Shop Management," by F. W. Taylor. The first of these stood for proper organization, suitable equipment and good management. The second made a strong point for exact knowledge of the condition of the work in shops and a record which would enable the management to know exactly what was on time and what delayed, and to know this every day. The third took the ground of large wages for large output. This paper by Mr. Taylor is a monumental work and one which is thoroughly worthy of study. Its length forbids abstracting and the reader is recommended to procure the paper itself from F. R. Hutton, secretary of the society, 12 West Thirty-first street, New York. This paper is a description of the methods of Mr. Taylor, and it discusses the problem of the payment for labor in a masterly way. Mr. Taylor goes into interesting details as to his elaborate methods of "time study," which is the foundation of his work. He also discusses the inducements which must be offered in order to lead men to do their best, and quotes results. Mr. Taylor writes and speaks of his methods with the force of personal conviction, and besides his actual accomplishments he will undoubtedly lead many to follow more systematic methods of studying the elements of work without which correct prices cannot be established. The discussion drifted into the subject of trades unionism, which is a most important factor in shop management. As a whole, this discussion was one of the most important and valuable ever had in the society. It brought out the fact that many bright men are earnestly attempting to solve the problem of shop management.

Of the remaining subjects, the most noteworthy was that of the steam turbine as described by Mr. F. A. Waldron. This paper will be presented in abstract. It shows conclusively that the steam turbine has literally leaped into a position before the mechanical world which entitles it to complete confidence as a satisfactory steam engine. While susceptible of improvement, it is now satisfactory and is likely to at once take a very prominent place for work to which it is adapted.

Lack of space prevents further comment on this very successful meeting.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

REPORT BY PROFESSOR GOSS.

XVIII.

Continued from Page 241.

43. *A Tabulated Statement of Stack Diameters.*—Experience having shown that equations, however simple in form, are less convenient than tabulated results derived therefrom, it has seemed best to present herewith the conclusions of the stack tests in tabulated form. In preparing the tables it has seemed wise to cover a range of dimensions embraced by wide limits. For this reason the minimum diameter of front-end is 30 ins. and the maximum 90 ins., and the stack heights are made to vary from 16 to 66 ins.

It should be evident to any one who has followed the discussions of the preceding paragraphs that the values given in the table have not in all cases been determined by experiments, but are those derived from the formulae based on the results of experiments as presented in the preceding article (Paragraph 41.). The values which in the tables appear in heavy faced type are experimental results; all others are derived. Tables XVI. to XXI., inclusive, give values for straight stacks, each table representing a different height.

TABLE XVI.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 16 Ins.

Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches.

Front End of Boiler Diameter in Ins.	Tip Below Center				Tip on Center	Tip Above Center				
	20	15	10	5		5	10	15	20	25
30	....	10.6	9.7	8.7	7.8	6.9	5.9	....	....	....
32	....	11.1	10.2	9.2	8.3	7.4	6.4	....	....	....
34	....	11.6	10.7	9.7	8.8	7.9	6.9	....	....	....
36	....	12.1	11.2	10.2	9.3	8.4	7.4	....	....	....
38	13.6	12.6	11.7	10.7	9.8	8.9	7.9	7.0	....	....
40	14.2	13.2	12.3	11.3	10.4	9.5	8.5	7.6	....	....
42	14.7	13.7	12.8	11.8	10.9	10.0	9.0	8.1	....	....
44	15.2	14.2	13.3	12.3	11.4	10.5	9.5	8.6	....	....
46	15.7	14.7	13.7	12.7	11.9	11.0	10.0	9.1	8.1	....
48	16.2	15.2	14.3	13.3	12.4	11.5	10.5	9.6	8.6	....
50	16.8	15.8	14.9	13.9	13.0	12.1	11.1	10.2	9.2	....
52	17.3	16.3	15.4	14.4	13.5	12.6	11.6	10.7	9.7	....
54	**17.8**	**16.8**	**15.9**	**14.9**	**14.1**	**13.1**	**12.1**	**11.2**	**10.2**	**9.3**
56	18.3	17.3	16.4	15.4	14.6	13.6	12.6	11.7	10.7	9.8
58	18.8	17.8	16.9	15.9	15.0	14.1	13.1	12.2	11.2	10.3
60	19.4	18.4	17.5	16.5	15.6	14.7	13.7	12.8	11.8	10.9
62	19.9	18.9	18.0	17.0	16.1	15.2	14.2	13.3	12.3	11.4
64	20.4	19.4	18.5	17.5	16.6	15.7	14.7	13.8	12.8	11.9
66	20.9	19.9	19.0	18.0	17.1	16.2	15.2	14.3	13.3	12.4
68	21.4	20.4	19.5	18.5	17.6	16.7	15.7	14.8	13.8	12.9
70	2.20	21.0	20.1	19.1	18.2	17.3	16.3	15.4	14.4	13.5
72	22.5	21.5	20.6	19.6	18.7	17.8	16.8	15.9	14.9	14.0
74	23.0	22.0	21.1	20.1	19.2	18.3	17.3	16.4	15.4	14.5
76	23.5	22.5	21.6	20.6	19.7	18.8	17.8	16.9	15.9	15.0
78	24.0	23.0	22.1	21.1	20.2	19.3	18.3	17.4	16.4	15.5
80	24.6	23.6	22.7	21.7	20.8	19.9	18.9	18.0	17.0	16.1
82	25.1	24.1	23.2	22.2	21.3	20.4	19.4	18.5	17.5	16.6
84	25.6	24.6	23.7	22.7	21.8	20.9	19.9	19.0	18.0	17.1
86	26.1	25.1	24.2	23.2	22.3	21.4	20.4	19.5	18.5	17.6
88	26.5	25.6	24.7	23.7	22.8	21.9	20.9	20.0	19.0	18.1
90	27.2	26.2	25.3	24.3	23.4	22.5	21.5	20.6	19.6	18.7

TABLE XVII.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 26 Ins.

Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches.

Front End of Boiler Diameter in Ins.	Tip Below Center				Tip on Center	Tip Above Center				
	20	15	10	5		5	10	15	20	25
30	....	11.2	10.5	9.3	8.4	7.5	6.5	....	....	....
32	....	11.7	10.7	9.7	8.9	8.0	7.0	....	....	....
34	....	12.2	11.3	10.3	9.4	8.5	7.5	....	....	....
36	....	12.8	11.9	10.9	10.0	9.1	8.1	....	....	....
38	14.4	13.4	12.5	11.5	10.6	9.7	8.7	7.8	....	....
40	15.1	14.1	13.2	12.1	11.2	10.3	9.3	8.4	....	....
42	15.6	14.6	13.7	12.7	11.8	10.9	9.9	9.0	....	....
44	16.2	15.2	14.3	13.3	12.4	11.5	10.5	9.6	....	....
46	16.7	15.7	14.8	13.8	12.9	12.0	11.0	10.1	9.1	....
48	17.3	16.3	15.4	14.4	13.5	12.6	11.6	10.7	9.7	....
50	17.8	16.8	15.9	14.9	14.0	13.1	12.1	11.2	10.2	....
52	18.3	17.3	16.4	15.4	14.5	13.6	12.6	11.7	10.7	....
54	**18.8**	**17.8**	**16.9**	**15.9**	**15.0**	**14.1**	**13.1**	**12.2**	**11.2**	**10.3**
56	19.3	18.3	17.4	16.4	15.5	14.6	13.6	12.7	11.7	10.8
58	19.9	18.9	18.0	17.0	16.1	15.2	14.2	13.3	12.3	11.4
60	20.4	19.4	18.5	17.5	16.6	15.7	14.7	13.8	12.8	11.9
62	21.0	20.0	19.1	18.1	17.2	16.3	15.3	14.4	13.4	12.5
64	21.5	20.5	19.6	18.6	17.7	16.8	15.8	14.9	13.9	13.0
66	22.1	21.1	20.2	19.2	18.3	17.4	16.4	15.5	14.5	13.6
68	22.6	21.6	20.7	19.7	18.8	17.9	16.9	16.0	15.0	14.1
70	23.2	22.2	21.3	20.3	19.4	18.5	17.5	16.6	15.6	14.7
72	23.7	22.7	21.8	20.8	19.9	19.0	18.0	17.1	16.1	15.2
74	24.3	23.3	22.4	21.4	20.5	19.6	18.6	17.7	16.7	15.8
76	24.8	23.8	22.9	21.9	21.0	20.1	19.1	18.2	17.2	16.3
78	25.4	24.4	23.5	22.5	21.6	20.7	19.7	18.8	17.8	16.9
80	25.9	24.9	24.0	23.0	22.1	21.2	20.2	19.3	18.3	17.4
82	26.5	25.5	24.6	23.6	22.7	21.8	20.8	19.9	18.9	18.0
84	27.0	26.0	25.1	24.1	23.2	22.3	21.3	20.4	19.4	18.5
86	27.7	26.7	25.8	24.8	23.9	23.0	22.0	21.1	20.1	19.2
88	28.1	27.1	26.2	25.2	24.8	23.4	22.4	21.5	20.5	19.6
90	29.8	28.8	27.9	26.9	25.0	24.1	23.1	22.2	21.2	20.8

TABLE XVIII.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 36 Ins.

Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches.

Front End of Boiler Diameter in Ins.	Tip Below Center				Tip on Center	Tip Above Center				
	20	15	10	5		5	10	15	20	25
30	....	11.5	10.6	9.6	8.7	7.8	6.8	....	....	....
32	....	12.0	11.1	10.1	9.2	8.3	7.3	....	....	....
34	....	12.6	11.7	10.7	9.8	8.9	7.9	....	....	....
36	....	13.2	12.3	11.3	10.4	9.5	8.5	....	....	....
38	14.8	13.8	12.9	11.9	11.0	10.1	9.1	8.2	....	....
40	15.4	14.4	13.5	12.5	11.6	10.7	9.7	8.8	....	....
42	15.9	14.9	14.0	13.0	12.1	11.2	10.2	9.3	....	....
44	16.7	15.7	14.6	13.6	12.7	11.8	10.8	9.9	....	....
46	17.1	16.1	15.2	14.2	13.3	12.4	11.4	10.5	9.5	....
48	17.7	16.7	15.8	14.8	13.9	13.0	12.0	11.1	10.1	....
50	18.2	17.2	16.3	15.3	14.5	13.6	12.6	11.7	10.7	....
52	18.8	17.8	16.9	15.9	15.0	14.1	13.1	12.2	11.2	....
54	**19.4**	**18.4**	**17.5**	**16.5**	**15.6**	**14.7**	**13.7**	**12.8**	**11.8**	**10.9**
56	20.0	19.0	18.1	17.1	16.2	15.3	14.3	13.4	12.4	11.5
58	20.6	19.6	18.7	17.7	16.8	15.9	14.9	14.0	13.0	12.1
60	21.2	20.2	19.3	18.3	17.4	16.5	15.5	14.6	13.6	12.7
62	21.7	20.7	19.8	18.8	17.9	17.0	16.0	15.1	14.1	13.2
64	22.3	21.3	20.4	19.4	18.5	17.6	16.6	15.7	14.7	13.8
66	22.9	21.9	21.0	20.0	19.1	18.2	17.2	16.3	15.3	14.4
68	23.5	22.5	21.6	20.6	19.7	18.8	17.8	16.9	15.9	15.0
70	24.1	23.1	22.2	21.2	20.3	19.4	18.4	17.5	16.5	15.6
72	24.6	23.6	22.7	21.7	20.8	19.9	18.9	18.0	17.0	16.1
74	25.2	24.2	23.3	22.3	21.4	20.5	19.5	18.6	17.6	16.7
76	25.8	24.8	23.9	22.9	22.0	21.1	20.1	19.2	18.2	17.3
78	26.4	25.4	24.5	23.5	22.6	21.7	20.7	19.8	18.8	17.9
80	27.2	26.2	25.3	24.3	23.2	22.3	21.3	20.4	19.4	18.5
82	27.5	26.5	25.6	24.6	23.7	22.8	21.8	20.9	19.9	19.0
84	28.1	27.1	26.2	25.2	24.3	23.4	22.4	21.5	20.5	19.6
86	28.7	27.7	26.8	25.8	24.9	24.0	23.0	22.1	21.1	20.2
88	29.3	28.3	27.4	26.4	25.5	24.6	23.6	22.7	21.7	20.8
90	29.9	28.9	28.0	27.0	26.1	25.2	24.2	23.3	22.3	21.4

TABLE XIX.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 46 Ins.

Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches.

Front End of Boiler Diameter in Ins.	Tip Below Center				Tip on Center	Tip Above Center				
	20	15	10	5		5	10	15	20	25
30	....	11.8	10.9	9.9	9.0	8.1	7.1	....	....	....
32	....	12.4	11.5	10.5	9.6	8.7	7.7	....	....	....
34	....	13.0	12.1	11.1	10.2	9.3	8.3	....	....	....
36	....	13.6	12.7	11.7	10.8	9.9	8.9	....	....	....
38	15.2	14.2	13.3	12.3	11.4	10.5	9.5	8.6	....	....
40	15.8	14.8	13.9	12.9	12.0	11.1	10.1	9.2	....	....
42	15.5	15.5	14.6	13.6	12.7	11.8	10.8	9.9	....	....
44	17.1	16.1	15.2	14.2	13.3	12.4	11.4	10.5	....	....
46	17.7	16.7	15.8	14.8	13.9	13.0	12.0	11.1	10.1	....
48	18.3	17.3	16.4	15.4	14.5	13.6	12.6	11.7	10.7	....
50	18.9	17.9	17.0	16.0	15.1	14.2	13.2	12.3	11.3	....
52	19.5	18.5	17.6	16.6	15.7	14.8	13.8	12.9	11.9	....
54	**19.1**	**18.1**	**18.2**	**17.2**	**16.3**	**15.4**	**14.4**	**13.5**	**12.5**	**11.6**
56	20.7	19.7	18.8	17.8	16.9	16.0	15.0	14.1	13.1	12.2
58	21.3	20.3	19.4	18.4	17.5	16.6	15.6	14.7	13.7	12.8
60	21.9	20.9	20.0	19.0	18.1	17.2	16.2	15.3	14.3	13.4
62	22.5	21.5	20.6	19.6	18.7	17.8	16.8	15.9	14.9	14.0
64	23.1	22.1	21.2	20.2	19.3	18.4	17.4	16.5	15.5	14.6
66	23.7	22.7	21.8	20.8	19.9	19.0	18.0	17.1	16.1	15.2
68	24.3	23.3	22.4	21.4	20.5	19.6	18.6	17.7	16.7	15.8
70	24.9	23.9	23.0	22.0	21.1	20.2	19.2	18.3	17.3	16.4
72	25.5	24.5	23.6	22.6	21.7	20.8	19.8	18.9	17.9	17.0
74	26.1	25.1	24.2	23.2	22.3	21.4	20.4	19.5	18.5	17.6
76	26.7	25.7	24.8	23.8	22.9	22.0	21.0	20.0	19.1	18.2
78	27.3	26.3	25.4	24.4	23.5	22.6	21.6	20.7	19.7	18.8
80	27.9	26.9	26.0	25.0	24.1	23.2	22.2	21.3	20.3	19.4
82	28.5	27.5	26.6	25.6	24.7	23.8	22.8	21.9	20.9	20.0
84	29.1	28.1	27.2	26.2	25.3	24.4	23.4	22.5	21.5	20.6
86	29.7	28.7	27.8	26.8	25.9	25.0	24.0	23.1	22.1	21.2
88	30.3	29.3	28.4	27.4	26.5	25.6	24.6	23.7	22.7	21.8
90	30.9	29.9	29.0	28.0	27.1	26.2	25.2	24.3	23.3	22.4

TABLE XX.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 56 Ins.

Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches.

Front End of Boiler Diameter in Ins.	Tip Below Center				Tip on Center	Tip Above Center				
	20	15	10	5		5	10	15	20	25
30	....	12.2	11.3	10.3	9.4	8.5	7.5	....	....	....
32	....	12.8	11.9	10.9	10.0	9.1	8.1	....	....	....
34	....	13.4	12.5	11.5	10.6	9.7	8.7	....	....	....
36	....	14.2	13.3	12.3	11.3	10.4	9.4	....	....	....
38	15.7	14.7	13.8	12.8	11.9	11.0	10.0	9.1	....	....
40	16.3	15.3	14.4	13.4	12.5	11.6	10.6	9.7	....	....
42	16.9	15.9	15.0	14.0	13.1	12.2	11.2	10.3	....	....
44	17.6	16.6	15.7	14.7	13.8	12.9	11.9	11.0	....	....
46	18.2	17.2	16.3	15.3	14.4	13.5	12.5	11.6	10.6	....
48	18.8	17.8	16.9	15.9	15.0	14.1	13.1	12.2	11.2	....
50	19.5	18.5	17.6	16.6	15.7	14.8	13.8	12.9	11.9	....
52	20.1	19.1	18.2	17.2	16.3	15.4	14.4	13.5	12.5	....
54	**20.8**	**19.8**	**18.9**	**17.9**	**17.0**	**16.1**	**15.1**	**14.2**	**13.2**	**12.3**
56	21.4	20.4	19.5	18.5	17.6	16.7	15.7	14.8	13.8	12.9
58	22.0	21.0	20.1	19.1	18.2	17.3	16.3	15.4	14.4	13.5
60	22.6	21.6	20.7	19.7	18.8	17.9	16.9	16.0	15.0	14.1
62	23.2	22.2	21.3	20.3	19.4	18.5	17.5	16.6	15.6	14.7
64	23.8	22.8	21.9	20.9	20.0	19.1	18.1	17.2	16.2	15.3
66	24.5	23.5	22.6	21.6	20.7	19.8	18.8	17.9	16.9	16.0
68	25.1	24.1	23.2	22.2	21.3	20.4	19.4	18.5	17.5	16.6
70	25.7	24.7	23.8	22.8	21.9	21.0	20.0	19.1	18.1	17.2
72	26.4	25.4	24.5	23.5	22.6	21.7	20.7	19.8	18.8	17.9
74	27.0	26.0	25.1	24.1	23.2	22.3	21.3	20.4	19.4	18.5
76	27.7	26.7	25.8	24.8	23.9	23.0	22.0	21.1	20.1	19.2
78	28.3	27.3	26.4	25.4	24.5	23.6	22.6	21.7	20.7	19.8
80	28.9	27.9	27.0	26.0	25.1	24.2	23.2	22.3	21.3	20.4
82	29.5	28.5	27.6	26.6	25.7	24.8	23.8	22.9	21.9	21.0
84	30.1	29.1	28.2	27.2	26.3	25.4	24.4	23.5	22.5	21.6
86	30.8	29.8	28.9	27.9	27.0	26.1	25.1	24.2	23.2	22.3
88	31.4	30.4	29.5	28.5	27.6	26.7	25.7	24.8	23.8	22.9
90	32.0	31.0	30.1	29.1	29.2	27.3	26.3	25.4	24.4	23.5

TABLE XXI.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 66 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	12.5	11.6	10.6	9.7	8.8	7.8	....	....	....
32	....	13.2	12.3	11.3	10.4	9.5	8.5	....	....	....
34	....	13.8	12.9	11.9	11.0	10.1	9.1	....	....	....
36	....	14.5	13.6	12.6	11.7	10.8	9.8	....	....	....
38	16.1	15.1	14.2	13.2	12.3	11.4	10.4	9.5	....	....
40	16.8	15.8	14.9	13.9	13.0	12.1	11.1	10.2	....	....
42	17.4	16.4	15.5	14.5	13.6	12.7	11.7	10.8	....	....
44	18.1	17.1	16.2	15.2	14.3	13.4	12.4	11.5	....	....
46	18.7	17.7	16.8	15.8	14.9	14.0	13.0	12.1	11.1	....
48	19.4	18.4	17.5	16.5	15.6	14.7	13.7	12.8	11.8	....
50	20.0	19.0	18.1	17.1	16.2	15.3	14.3	13.4	12.4	....
52	20.7	19.7	18.8	17.8	16.9	16.0	15.0	14.1	13.1	....
54	**21.4**	**20.4**	**19.5**	**18.5**	**17.6**	**16.7**	**15.7**	**14.8**	**13.8**	**12.9**
56	22.0	21.0	20.1	19.1	18.2	17.3	16.3	15.4	14.4	13.5
58	22.7	21.7	20.8	19.8	18.9	18.0	17.0	16.1	15.1	14.2
60	23.3	22.3	21.4	20.4	19.5	18.6	17.6	16.7	15.7	14.8
62	24.0	23.0	22.1	21.1	20.2	19.3	18.3	17.4	16.4	15.5
64	24.6	23.6	22.7	21.7	20.8	19.9	18.9	18.0	17.0	16.1
66	25.3	24.3	23.4	22.4	21.5	20.6	19.6	18.7	17.7	16.8
68	25.9	24.9	24.0	23.0	22.1	21.2	20.2	19.3	18.3	17.4
70	26.6	25.6	24.7	23.7	22.8	21.9	20.9	20.0	19.0	18.1
72	27.2	26.2	25.3	24.3	23.4	22.5	21.5	20.6	19.6	18.7
74	28.9	27.9	26.0	25.0	24.1	23.2	22.2	21.3	20.8	19.4
76	28.5	27.5	26.6	25.6	24.7	23.8	22.8	21.9	20.9	20.0
78	29.2	28.2	27.3	26.3	25.4	24.5	23.5	22.6	21.6	20.7
80	29.8	28.8	27.9	26.9	26.0	25.1	24.1	23.2	22.2	21.3
82	30.5	29.5	28.6	27.6	26.7	25.8	24.8	23.9	22.9	22.0
84	31.1	30.1	29.2	28.2	27.3	26.4	25.4	24.5	23.5	22.6
86	31.8	30.8	29.9	28.9	28.0	27.1	26.1	25.2	24.2	23.3
88	32.4	31.4	30.5	29.5	28.6	27.7	26.7	25.8	24.8	23.9
90	33.1	32.1	31.2	30.2	29.3	28.4	27.4	26.5	25.5	24.6

TABLE XXII.

Taper Stacks.

Diameter at Chock of Stack for any Height when Stack Tapers 2 Ins. to the Foot.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	....	9.1	8.3	7.5	6.7	5.9	....	....	....
32	....	....	9.6	8.8	8.0	7.2	6.4	....	....	....
34	....	10.9	10.1	9.3	8.5	7.7	6.9	....	....	....
36	....	11.4	10.6	9.8	9.0	8.2	7.4	....	....	....
38	12.7	11.9	11.1	10.3	9.5	8.7	7.9	7.1	....	....
40	13.2	12.4	11.6	10.8	10.0	9.2	8.4	7.6	....	....
42	13.7	12.9	12.1	11.3	10.5	9.7	8.9	8.1	....	....
44	14.2	13.4	12.6	11.8	11.0	10.2	9.4	8.6	....	....
46	14.7	13.9	13.1	12.3	11.5	10.7	9.9	9.1	8.3	....
48	15.2	14.4	13.6	12.8	12.0	11.2	10.4	9.6	8.8	....
50	15.7	14.9	14.1	13.3	12.5	11.7	10.9	10.1	9.3	....
52	16.2	15.4	14.6	13.8	13.0	12.2	11.4	10.6	9.8	....
54	**16.7**	**15.9**	**15.1**	**14.3**	**13.5**	**12.7**	**11.9**	**11.1**	**10.3**	**9.5**
56	17.2	16.4	15.6	14.8	14.0	13.2	12.4	11.6	10.8	10.0
58	17.7	16.9	16.1	15.3	14.5	13.7	12.9	12.1	11.3	10.5
60	18.2	17.4	16.6	15.8	15.0	14.2	13.4	12.6	11.8	11.0
62	18.7	17.9	17.1	16.3	15.5	14.7	13.9	13.1	12.3	11.5
64	19.2	18.4	17.6	16.8	16.0	15.2	14.4	13.6	12.8	12.0
66	19.7	18.9	18.1	17.3	16.5	15.7	14.9	14.1	13.3	12.5
68	20.2	19.4	18.6	17.8	17.0	16.2	15.4	14.6	13.8	13.0
70	20.7	19.9	19.1	18.3	17.5	16.7	15.9	15.1	14.3	13.5
72	21.2	20.4	19.6	18.8	18.0	17.2	16.4	15.6	14.8	14.0
74	21.7	20.9	20.1	19.3	18.5	17.7	16.9	16.1	15.3	14.5
76	22.2	21.4	20.6	19.8	19.0	18.2	17.4	16.6	15.8	15.0
78	22.7	21.9	21.1	20.3	19.5	18.7	17.9	17.1	16.3	15.5
80	23.2	22.4	21.6	20.8	20.0	19.2	18.4	17.6	16.8	16.0
82	23.7	22.9	22.1	21.3	20.5	19.7	18.9	18.1	17.3	16.5
84	24.2	23.4	22.6	21.8	21.0	20.2	19.4	18.6	17.8	17.0
86	24.7	23.9	23.1	22.3	21.5	20.7	19.9	19.1	18.3	17.5
88	25.2	24.4	23.6	22.8	22.0	21.2	20.4	19.6	18.8	18.0
90	25.7	24.9	24.1	23.3	22.5	21.7	20.9	20.1	19.3	18.5

TABLE XXIII.

Best Draft.

Obtainable Under Conditions of Constant Speed and Cut-Off with Different Heights of Stack in Connection with Different Heights of Exhaust Nozzle.

Nozzle.	1 Draft.	Difference.	2 Draft.	Difference	3 Draft.	Difference.	4 Draft.	Difference.	5 Draft.	Difference	6 Draft.	Difference.	7 Draft.	Difference.
Stack 2—D	4.0	...	4.2	...	4.0	...	3.9	...	4.0	...	3.4	...	3.2	...
Stack 2—C	3.5	.5	3.8	.4	3.7	.3	3.5	.4	3.5	.5	3.1	.3	2.7	.5
Stack 2—B	3.1	.4	3.2	.6	3.3	.4	3.0	.5	2.9	.6	2.5	.6	2.2	.5
Stack 2—A	2.3	.8	2.4	.8	2.6	.7	2.4	.6	2.2	.7	2.0	.5	1.6	.6
Total difference.		1.7		1.8		1.4		1.5		1.8		1.4		1.6

44. *Unavoidable Loss of Draft with Reduction in Height of Stack.*—The equations already presented, together with the tabulated statements based thereon, are assumed to give the best diameter for a stack of any given height. They can not be depended upon to give results which will always be satisfactory under conditions which greatly limit or restrict the height. In general, the best draft obtainable from a short stack is inferior to that obtained from a longer stack. The most that can be done when the limit of height has been fixed is to determine a diameter which, in combination with that height, will give best results. It is this and this only that the equations, and the tables based thereon, are assumed to do.

The rate at which the draft diminishes with each reduction in height of stack is indicated by Figs. 103 to 106, presenting results plotted in terms of draft and stack-height. In explanation of these figures it should be noted that the stack-heights represented are: Base, 16½ ins.; A, 26½ ins.; B, 36½ ins.; C, 46½ ins., and D, 56½ ins. Figure 103 gives results with the smallest tapered stack in combination with the lowest nozzle; Fig. 104 those for the largest tapered stack in combination with the lowest nozzle, and Figs. 105 and 106 those for the smallest and the largest tapered stacks, respectively, for a series of tests at different cut-offs. In all of these figures it will be seen that there is a marked decrease in the draft obtained for each reduction in the height of stack. This is the more significant when it is considered that these diagrams represent only tapered stacks and that the diameter of the choke of such stacks is not required to be changed when the stack is varied in height. It is clear, therefore, that these diagrams confirm the statement already made to the effect that a short stack, however well designed, must be inferior in its draft-producing qualities to a longer stack of good design. There is, in fact, nothing in the relation of diameter to height, or, so far as the investigation has proceeded, in the form of the stack itself, which can be accepted as a complete substitute for height. Again, this loss in draft with changes in height of stack does not depend upon the height of the nozzle. Thus, Table XXIII. represents a summary of results in connection with all heights of the smallest tapered stack in combination with all heights of nozzle. The table shows that whatever the height of the nozzle, the loss in draft under the conditions represented in passing from the D, or 56½ in. height, to the A, or 26½ in. height, is a fixed quantity and under the conditions of the tests referred to is approximately represented by 1.6 in. of water. Thus, for the nozzle No. 1, it is 1.7 in.; for the nozzle No. 3, 1.4 in.; for the nozzle No. 5, 1.8 in.; for the nozzle No. 7, 1.6 in.

It is difficult to find a quantitative measure for the loss of draft resulting from reduction in height of stack which will be of general application. The extent of such loss is, however, suggested by the slope of the lines in the figures already referred to, and by the differences in Table XXIII. The general conclusion is, however, clear. It is apparent that the shorter stacks are far inferior to those of greater length and that the maintenance of draft values in connection therewith must necessarily involve the application of additional mechanism, or an increase in the energy of the exhaust jet. The present study does not suffice to indicate what should be the character of such additional mechanism or the extent of the necessary increase in the energy of the exhaust jet. It is, however, altogether possible that the adoption of some form of inside stack or of draft-pipes may make good the loss resulting from the diminished length of outside stack.

45. *Relative Advantage of Straight and Tapered Stacks.*—But two forms of stacks were employed in the experiments under discussion, one being perfectly cylindrical, and hence referred to as the straight stack; the other having the form best shown by Fig. 26, and generally referred to as the tapered stack. This tapered stack has its least diameter, or "choke," at a point 16½ ins. from the bottom and increases in diameter uniformly above this point, the angle of the sides being the same for all stacks, and the divergence being at the rate of 2 ins. in diameter for each foot in length. This divergence corresponds with that which was found best, as a result of the well-known von Borries-Troske tests. The most noteworthy difference in results obtained from the two contours is to be found in the increased capacity of the tapered stack. Thus, No. 2 stack (9¾ ins. diameter), which is the smallest of the tapered stacks, gives draft values which are two or three times as great as those obtained with No. 1, which is a straight stack of the same diameter. While the results from No. 2 are none of them sufficiently meritorious to warrant a place in the table of best results (Table XV.), they give a close approach thereunto. The two smaller diameters of straight stacks, Nos. 1 and 3 (9¾ ins. and 11¾ ins. diameter) are both far too small to yield results which are to be regarded as satisfactory, the capacity of these stacks being insufficient for the work expected of them. Speaking in rather general

terms, it may be said that a tapered stack having a diameter of choke 9¾ ins. has as great a capacity as a cylindrical stack of 13¾ ins. Again, only the largest diameter of straight stack, No. 7 (15¾ in. diameter) has a place in the table of best results, whereas all diameters of the tapered stack excepting the least, find places in the table. It is of interest to note that with the low nozzle, tapered stack 6 B (least diameter 13¾ ins., total height 36½ ins.) gives identical results with straight stack 7 C (diameter 15¾ ins., height 46½ ins.), the tapered stack being 10 ins. lower and 2 ins. less in diameter than the straight stack.

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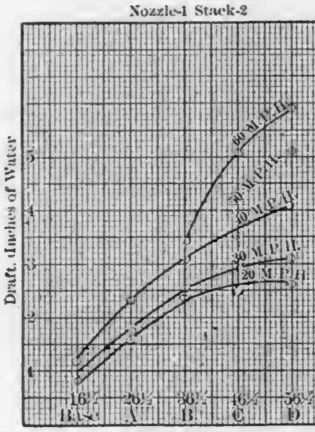

Fig. 103

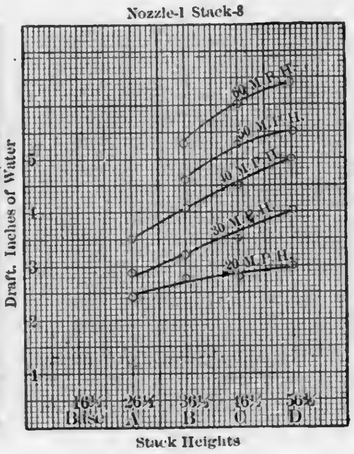

Fig. 104

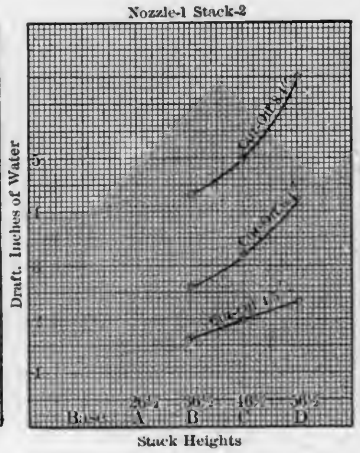

Fig. 105

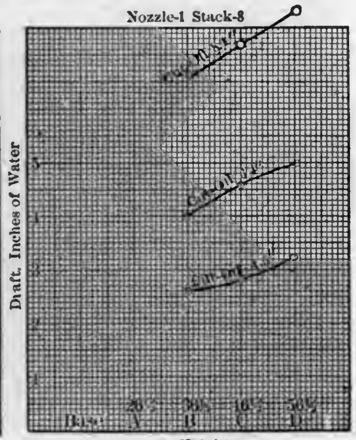

Fig. 106

the diameter of the straight stack must change for every change in height, that of the tapered stack remains constant for all heights. In this connection, it is important to remember that the diameter of the tapered stacks referred to is the diameter of the choke (least diameter). As a matter of fact, if designs based on the equations which have been deduced were to be superimposed they will show that while the tapered stack, as compared with the straight stack, is of a lesser diameter at the choke, the diameter of its top will generally exceed that of the straight stack.

In general, it would seem that the tapered stack is less susceptible to minor changes of proportion, both of the stack itself and of the surrounding mechanism, than the straight stack. Thus, a variation of an inch or two in the diameter of the tapered stack affects the draft less than a similar change in the diameter of the straight stack. Again, the tapered stack is generally less affected by variations in the height of the nozzle so that altogether it appears, quite contrary to the expectation of the experimenter, that the use of the tapered stack gives a greater degree of flexibility in the design of the dependent parts. *For these reasons, in the opinion of the undersigned, the tapered form appears to be altogether preferable to the straight form.*

46. *Draft, a Function of Weight of Steam Exhausted.*—Attention has already been called to the fact that a good arrangement of nozzle and stack appears to be equally efficient under whatever conditions the engine may run. A combination which is good for one speed is good for all speeds, and a combination which is good for one cut-off is good for all cut-offs. While this is true, it goes without saying that draft values change when there is a change in the manner of running; that at a constant cut-off, an increase of speed increases draft values; and at a constant speed and throttle opening, increasing the cut-off, increases the draft values. In other words, whatever tends to increase the volume of steam exhausted in a given time, augments the draft values. When the number of pounds of steam exhausted per minute is doubled, the draft as measured in inches of water is doubled. These facts have already been presented in another connection (Article 38), and are repeated here by way of emphasis. The extent to which the general statement is true appears in the comparisons made possible by Table XIV.

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Before attempting to discuss inside stacks, it should be remembered that the results of tests involving outside stacks show that when other things are unchanged, the higher the stack, the better the draft; that when, through increased diameter of the boiler, it becomes necessary to reduce the height of the stack, there inevitably results a loss in draft. This being true of the outside stack, it becomes important to know whether an extension of the stack downward into the smoke-box will serve to hold up the efficiency of the draft when the length of the outside portion of the stack is diminished. In a discussion of this matter at the Convention of the American Master Mechanics' Association at Saratoga in June last (1902) the undersigned expressed the opinion that the extension of the stack downward into the smoke-box would in part compensate for the loss of length outside of the smoke-box. Since that time the matter has received careful attention and while the material at hand will hardly sustain a definite conclusion, it points to a conclusion and is of sufficient interest to warrant its presentation.

(*To be Concluded.*)

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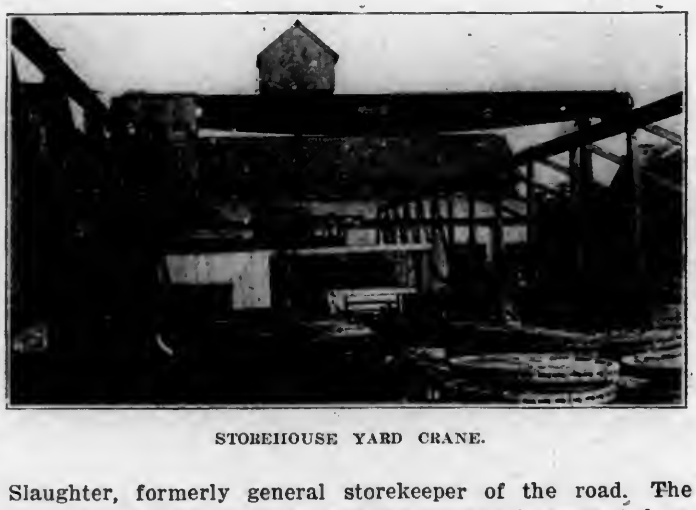
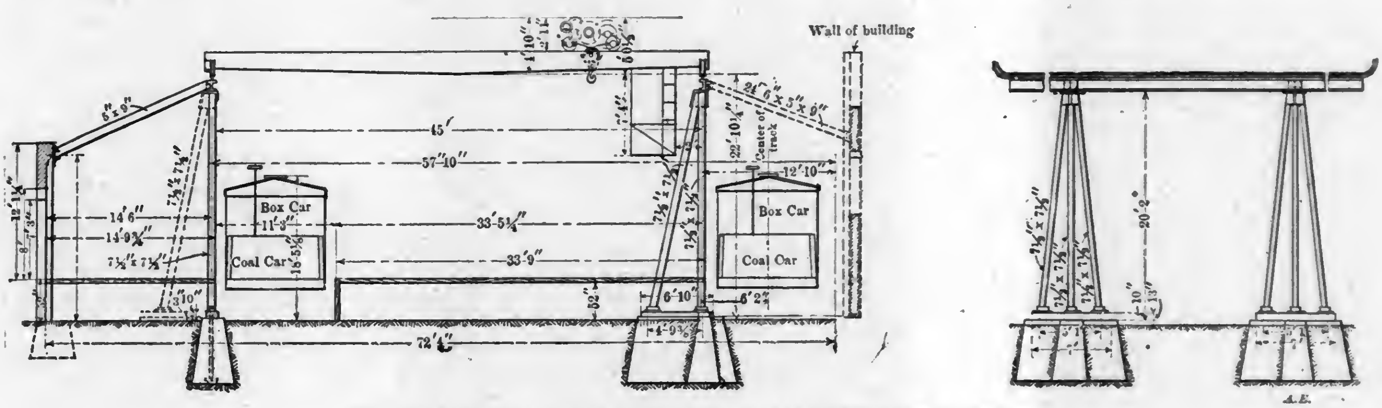
CHICAGO & NORTHWESTERN RAILWAY.

At the general storehouse of this road at the Chicago shops a large amount of heavy material is kept in stock and frequently handled. In order to reduce the labor cost an inexpensive and effective crane service was arranged by Mr. G. F. Slaughter, formerly general storekeeper of the road. The crane has a span of 45 ft. and the runway is supported on wooden frames spanning that portion of the yard in which such material as driving-wheel centers, ties, cylinders, frogs, pilots, boiler fronts and other heavy parts are stored. The


STOREHOUSE YARD CRANE.

crane lifts five tons and is driven by motors, taking current from the power circuit of the shops. The idea of a crane for handling storehouse material is not new, but present conditions require such apparatus in all large storehouse establishments, and there can be few small investments which will give such large returns in the reduction of labor charges. With this crane two men do the work formerly requiring ten. The runway is 475 ft. long. Every large storehouse should have such facilities.



STOREHOUSE YARD CRANE.—CHICAGO & NORTHWESTERN RAILWAY.

We are indebted to Mr. Robert Quayle, superintendent of motive power, and Mr. W. E. Dunham, mechanical engineer, for the drawing and photograph.

MASTER MECHANICS' ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.—CONTINUED.

PISTON VALVES.

In the discussion of the report of the committee on this subject, which appeared in abstract on page 274 of our July number, Mr. John Player presented the following remarks:

One of the first questions brought up in the paper was the relative use of the hollow or solid-ended piston valve. The report states that the preference seems to be for the hollow valve, that is, with the exhaust cavity passing entirely through the valve. The original piston valves which we constructed, and which other roads have also applied, had the hollow cavity for the exhaust, with the supposition of producing an entirely balanced valve. We found, however, with that valve that at the period of commencement of exhaust the exhaust pressure had a tendency to accelerate the motion of the valve, or in other words, increase the pressure against the exhaust packing ring. There was an objection at that time, chiefly raised by engineers, to the sound of the exhaust of the piston valve, that it was muffled; it was, in comparison to the exhaust of a slide valve. We also found that the exhaust was not quite as sharp from the piston-valve engine, although you could run with a nozzle the same size as with slide-valve engines, yet the exhaust did not sound as sharp and there was a tendency to close up the exhaust tips to produce the sound. To overcome that we made the ends of the valve followers solid and built a great number of engines with the ordinary two-opening exhaust, with both cavities opening into the same chamber, same as with a slide valve. We found that the acceleration of the valve at the period of commencement of exhaust was practically not increased to any appreciable extent by making the ends solid. Shortly after that we introduced a further betterment in the adoption of a four-opening exhaust, by making two exhaust cavities in each cylinder entirely separate, and carrying them upward in the exhaust pipe, and making the exhaust pipe with four openings at the base, carrying two a portion of the way up and the other two higher, the proportions of the exhaust pipe above that being approximately the same as those recommended by the association. We found by the adoption of this exhaust cavity and pipe we were able to enlarge the nozzles on an identically similar engine, enlarging the exhaust tip anywhere from 3-16 to ⅜ of an inch, showing the benefit of the solid end valve with the separate exhaust. The objection that has been raised that there was an exhaust pressure on the ends of the valve, does not hold in this case. For one thing, we get a larger opening at the exhaust tip which relieves the back pressure. The indicator cards show the back pressure is lower than that in any slide-valve engine with open ends. There has been some trouble with relief valves on the cylinder heads. Relief valves with piston valves are a necessity on cylinder heads, especially at high speeds. In some places they screw them down instead of adjusting them at proper pressure, and consequently they do not work. They should be made so that they cannot be "monkeyed" with. As to the by-pass valve, it is beginning to be an appreciated fact that by-pass valves combined with piston valves are a benefit, especially upon engines that have to do drifting. Some of the former patterns of by-pass valves that were applied to piston-valve engines were not altogether a success. The areas were insufficient in the first place, and the construction of the valve was such that they had a tendency to stick, and sufficient attention was not paid to them to keep them in order. All that trouble has been eliminated in the improved form, and they are a necessity upon passenger and freight engines that do much drifting.

With relation to circulation pipes, they perform practically the same function as the by-pass valve, but have a tendency to freeze up which is not a desirable feature. The results accomplished by the circulation pipe can be accomplished by a good construction of by-pass valve. As to the packing rings, reference has been made to the abandonment of substitution of some other form for the L-shaped ring. Some of them were made entirely too light in section, and the projection over the follower was entirely disproportionate to the section of the ring itself in some of the early forms. Any properly proportioned L-shaped ring is the ring to use, as it gives a proper cut-off edge. One objection to using them in solid valves has been there is some trouble in springing them over, so that you start an initial strain in the metal which causes breakage afterward, but with the follower we have there is practically no breakage in the L-shaped rings if the valves are properly lubricated. Regarding the valve stem connections, they should be made flexible where practicable. The valve, in my judgment, should be supported by the stems at both ends in bushings, so as to relieve the weight of the valve on the bushing itself. I have seen valves supported at both ends that ran two years and a half, where the tool marks were scarcely worn off the bottom of the valve.

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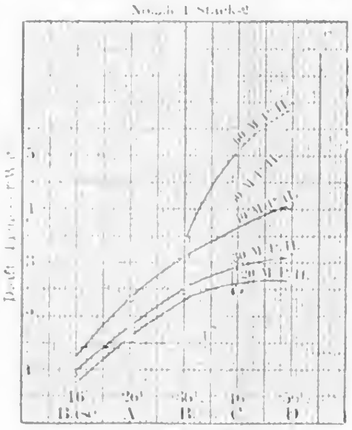


Fig. 103

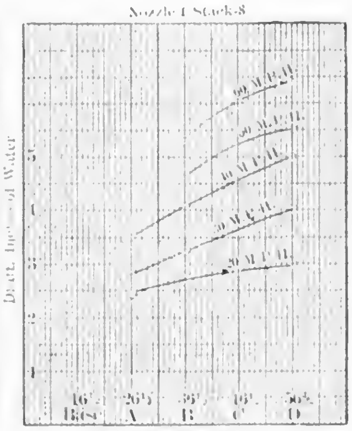


Fig. 104

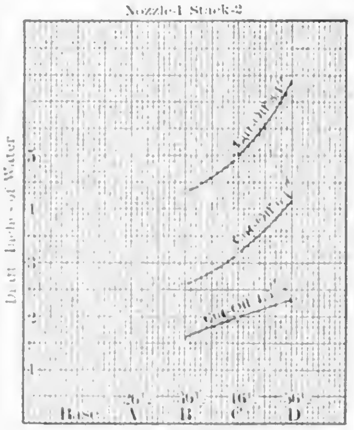
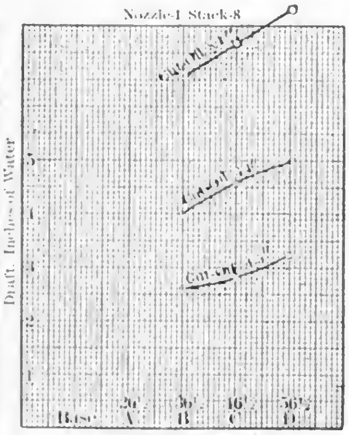


Fig. 105



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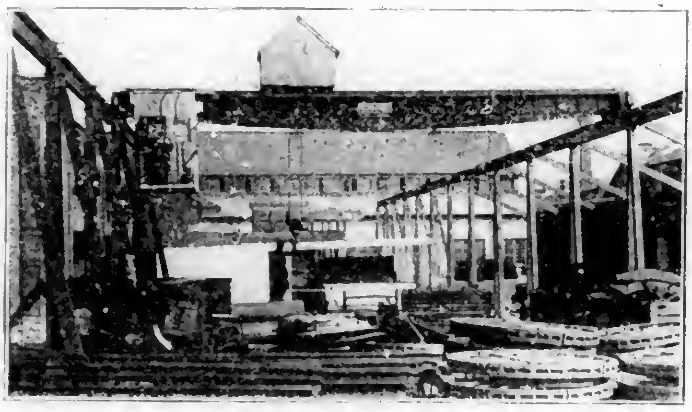

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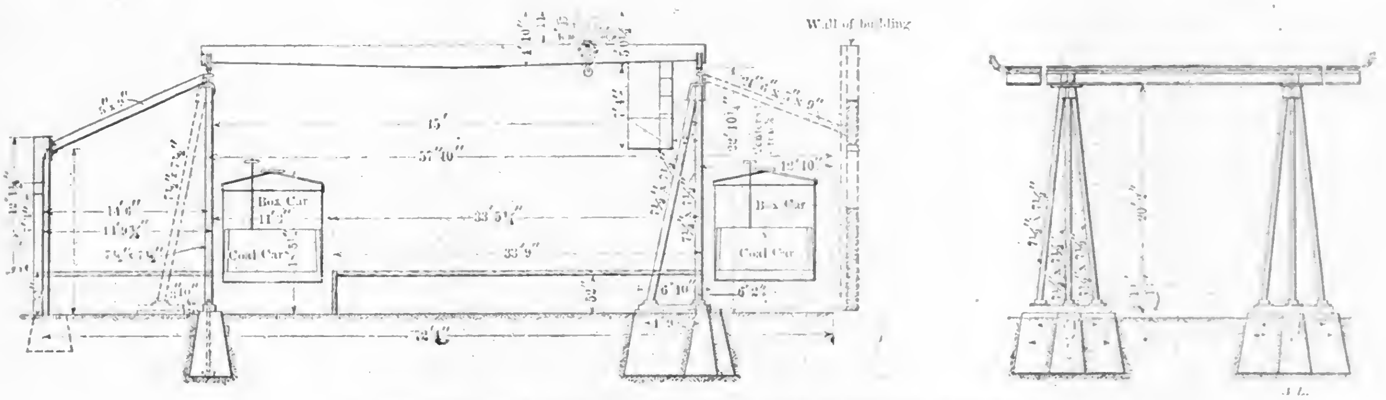

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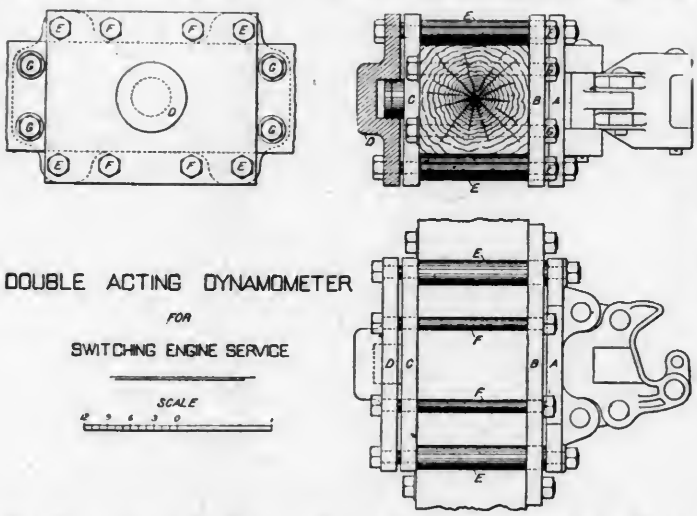
service years ago, why is it that the British Government, the United States Government, and all these large transatlantic steamer lines are using piston valves? If the slide valve is better, why do they not use it?

With regard to the trouble that has been mentioned in handling piston valves, as to the dropping down in the corner and the racking of the valve motion occasioned by it, proper instructions should be issued to engineers for the proper handling of piston-valve engines to the effect that, as the last speaker suggested, the lever should not be dropped down while the engine is speeding, but dropped down gradually as the speed decreases as you are going into a station. The object of this is obvious. The piston valve runs in a bushing, and not over a plain surface like the slide valve. The lubrication for the bushing and valve is taken in the middle, and the lubricated surface is that over which the packing rings travel. The surface covered by the exhaust steam, which is not covered by the travel of the valve when working, becomes dry and encrusted to a certain extent with the scum which you usually find in a steam chest. When you drop the lever in full gear, you have to cut that all off at one stroke, practically speaking, or else it snaps in the packing rings and the packing rings travel over it, and the fact of always dropping the lever down at speed is one of the most serious objections in the use of piston valves. It causes practically all the trouble of breakage of packing rings and the failures of the valve motion referred to. If the valve is handled in a proper manner, not dropped down when running at speed, but as you slow down drop it down gradually, there will be no trouble experienced with the piston-valve cylinder.

A LOCOMOTIVE DYNAMOMETER.

In the discussion of the report on ton mile statistics before the Master Mechanics' Association Mr. G. L. Fowler described a dynamometer, designed by him.

The bumper timber is shown in the upper right hand corner. There is a plate B bolted securely to it by bolts G. This plate is immovable, and is attached to the buffer. The coupler is attached rigidly to the plate A. Passing through the plate A is the bolt E, with a heavy shoulder against the plate A, and also another shoulder against the plate C, so that if A is pushed back by buffing, the plate C is carried back with it. The hydraulic cylinder is shown at D and is bolted by the bolts F to the plate B. If there is a buffing stress applied to the coupler, the plate C is pushed back



DOUBLE ACTING DYNAMOMETER FOR SWITCHING ENGINE SERVICE

and the plunger exerts a pressure in the cylinder. If there is a pulling stress, the plate A is moved away and pulls against the cylinder D by means of the bolts E; but the plate C cannot follow it and comes up against the buffer beam, and that also puts a pressure in the cylinder. A Bristol recording gauge is to be used with this dynamometer.

SPECIFICATIONS FOR LOCOMOTIVE AXLES AND FORGINGS.

COMMITTEE—F. H. CLARK, J. E. SAGUE, S. M. VAUCLAIN, L. R. POMEROY.

First.—To submit specifications for locomotive driving and truck axles.

Second.—To submit specifications for locomotive forgings.

Third.—To co-operate with the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Society for Testing Materials, with a view of bringing about standard specifications for locomotive axles and forgings. Your committee, therefore, in presenting the specifications below does not expect their adoption as standard, but hopes that a discussion of the subject will enable the committee to take the matter up with the other associations named with a better understanding of the wishes of this association.

PROPOSED SPECIFICATIONS FOR LOCOMOTIVE DRIVING AND ENGINE TRUCK AXLES.

Material, open-hearth steel.

Phosphorus, not to exceed...........	.05 per cent.
Sulphur, not to exceed.............	.05 per cent.
Manganese, not to exceed...........	.60 per cent.

Tensile strength—not less than 80,000 lbs. per square inch.
Elongation in 2 ins., not less than 20 per cent.
Reduction in area, not less than 35 per cent.

One test per melt will be required, the test specimen to be taken from either end of any axle with a hollow drill, half way between the center and the outside, the hole made by the drill to be not more than 2 ins. in diameter, nor more than 4½ ins. deep. The standard turned test specimen, ½ in. in diameter and 2 ins. gauge length, shall be used to determine the physical properties. (See Fig. 1.) Drillings or turnings from the tensile specimens shall be used to determine the chemical properties.

Each axle must have heat number and manufacturer's name plainly stamped on one end, with stamps not less than ⅜ in., and have order number plainly marked with white lead.

All axles must be free from seams, pipes and other defects, and must conform to drawings accompanying these specifications. Axles must be rough-turned all over, with a flat-nosed tool, cut to exact length, have ends smoothly finished and centered with 60-deg. centers. Axles failing to meet any of the above requirements, or which prove defective on machining, will be rejected.

The above specifications for locomotive driving and truck axles is believed to be fair to both manufacturer and purchaser. The physical test outlined is one which should insure proper hammer work and it has also the following further points in its favor: (1) It does not show the manufacturer which axle is to be selected for test. (2) The axle tested is not destroyed, but is available for use if it meets the requirements. (3) The test may be used in the purchase of small lots, most orders from railroad companies being for from six to ten axles. (4) The test does not require a discard and in no way adds to the cost of the axle. (5) It furnishes the manufacturer with a check of the work done in his plant. (6) The test is one largely used by the United States Government for forgings.

PROPOSED SPECIFICATIONS FOR LOCOMOTIVE FORGINGS.

Material, open-hearth steel.

Phosphorus, not to exceed...........	.05 per cent.
Sulphur, not to exceed.............	.05 per cent.
Manganese, not to exceed...........	.60 per cent.

Tensile strength, not less than 80,000 lbs. per square inch.
Elongation, not less than 20 per cent. in 2 ins.
Reduction in area, not less than 35 per cent.

One test per melt will be required, the test specimen to be cut cold from the forging, or full-sized prolongation of same, parallel to the axis of the forging and half way between the center and the outside. The standard turned specimen, ½ in. in diameter and 2 ins. gauge length, shall be used to determine the physical properties. (See Fig. 1.) Drillings or turnings from the tensile specimen shall be used to determine the chemical properties.

Each forging must have heat number and name of manufacturer plainly stamped on one end with figures not less than ⅜ in. and have order number plainly marked with white lead.

All forgings must conform to drawings which accompany these specifications, and be free from seams, pipes and other defects. Any forgings failing to meet any of the above requirements, or which prove defective on machining, will be rejected.

The above specificaton for locomotive forgings is based upon the recommendation of the American Society for Testing Material, with some slight modifications, which, it is believed, will tend to improve the product. The physical test is substantially the same as that recommended above for testing locomotive driving and truck axles, and the same arguments may be used in its favor.

PROPOSED SPECIFICATIONS FOR STEEL BLOOMS AND BILLETS FOR LOCOMOTIVE FORGINGS.

Material, open-hearth steel.

Grade "A:"
Tensile strength, 70,000 lbs. per square inch.
Elongation in 2 ins., 20 per cent.

Grade "B:"
Tensile strength, 80,000 lbs. per square inch.
Elongation in 2 ins., 17 per cent.

Grade "A:"

Carbon	.25 to .40 per cent.
Phosphorus, not to exceed...........	.06 per cent.
Sulphur, not to exceed.............	.06 per cent.
Manganese, not to exceed...........	.60 per cent.

Grade "B:"

Carbon	.35 to .50 per cent.
Phosphorus, not to exceed...........	.05 per cent.
Sulphur, not to exceed.............	.05 per cent.
Manganese, not to exceed...........	.60 per cent.

One test per melt should be required, the test specimen to be cut cold from the bloom, parallel to its axis and half way between the center and the outside. The standard turned test specimen, ½ in. in diameter, and 2 ins. gauge length, shall be used to determine the physical properties. (See Fig. 1.) Drillings or turnings from the tensile specimen shall be used to determine the chemical properties.

Each bloom or billet must have heat number and manufacturer's name plainly stamped on one end, with stamps not less than ⅜ in. and have order number plainly marked with white lead.

Blooms and billets must be free from checks, pipes and surface defects. Any blooms or billets chipped to a depth greater than ½ in. will be rejected. Any billet or bloom failing to meet the

above requirements will be rejected and held, subject to disposal by manufacturers. Inspector to have the privilege of taking drillings from the center of the top bloom or billet of the ingot in

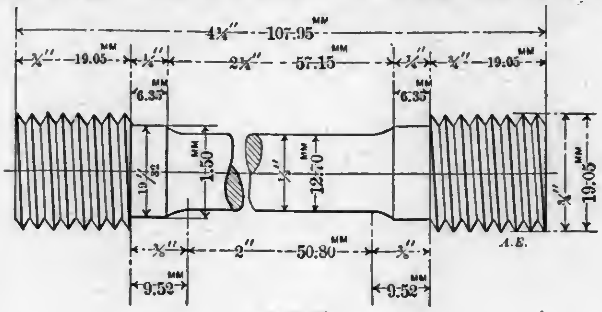


FIG. 1.

order to determine the amount of segregation. Grade "A" is blooms or billets for rod straps and miscellaneous forgings. Grade "B" is blooms or billets for driving and truck axles, connecting rods, crankpins and guides.

INTERNAL COMBUSTION ENGINE IN RAILWAY SERVICE.

AN INDIVIDUAL PAPER BY R. P. C. SANDERSON.

Had the internal combustion engine been invented before the steam engine, it is reasonably certain now that the latter would never have been developed and assumed the important standing in the industrial accomplishment that it has to-day, but the internal combustion engine would be in its place, doing its work and very much more efficient than it is to-day.

The mechanical genius of this country and Europe has, for years, been striving with really wonderful results to improve the efficiency of the steam engine, and when we compare the high pressure, quadruple expansion steam engines with surface condensers of to-day, with the long stroke, low pressure single expansion engines of fifty years ago, the coefficient of efficiency tells the story of the progress made during that interval of time in perfecting the steam engine and boiler.

But, apart from the perfection of workmanship and design of the boiler, and the skill in making the engine develop the greatest amount of power with the least amount of steam, there are inherent losses in the process of converting the energy of coal or oil into power at the crank, which can never be eliminated in the steam engine and boiler. No boiler can be made which will absorb all the heat which can be given by the coal. There is a loss in the boiler due to the evaporation of water into steam, and other losses with which we are all familiar. The process itself is an extravagant and wasteful one.

To illustrate this. If we take an engine of reasonable efficiency in ordinary service (I do not now refer to the highest type of multiple expansion or condensing engines), with a reasonably good boiler, we cannot expect to get a brake horse-power for much less than five or six pounds of coal per horse-power per hour.

In the present imperfect condition of the internal combustion engine there is no difficulty in getting a brake horse-power for one pound of coal per hour from producer gas, where nothing is wasted but the ashes, and, of course, some heat in the producer itself necessarily, due to the change of the carbon from its fixed form into that of fuel gas.

Gas engines are now made not only in the size of toys, but up to 2,500 horse-power units. Formerly the waste gas from the blast furnaces was used in part for heating stationary boilers and furnishing steam to drive the blowing engines for the furnace. These boilers generally had to be supplemented with coal fuel to get enough steam to run the engines. Nowadays the steam boilers and steam engines have given place to powerful internal combustion engines, where the gas from the furnaces is burnt direct in the cylinders of engines and produces all power necessary for doing the blowing. A moment's thought of the immense saving this means in connection with the statement made above with regard to the possibility of producing power for anywhere from one-third to one-eighth of the amount of coal that is now being used for steam purposes in steam engines and boilers will indicate to the minds of members who wish to consider this matter what the possibilities are for the future.

In producing gas, one of the principal troubles and sources of expense of installation is necessitated for gas holders of large capacity to carry a sufficient supply of gas to meet the varying demands. Recent developments, it is understood, have made even this unnecessary, as gas producers, operating continuously, have been invented which furnish gas directly from the producer to engine, and which can be driven with varying capacity to satisfy the demands of the engine, just as a steam boiler is driven to meet the requirements for steam as demanded by the engine.

As gas producers will make good fuel gas from poor coal, without trouble from clinker, and as gas can be successfully used for every purpose in railroad service, not only for producing power, but also for doing work in the shop furnaces, for tinner's work, for blacksmith forges, for welding flues, for flanging and annealing boiler plates, for heavy forgings, for brazing, etc., it is quite practicable at any shop installation to put in a battery of producers, to turn the cheapest grade of slack coal into fuel gas. This can be used for driving individual shops or groups by gas engines located around the plant, if so desired, the gas being taken to them by piping—for all smith shop and foundry purposes, etc., or the gas engines can be located in the central power house and used to drive electric dynamos for power and light, the current being carried by wire to the individual machines or motors for group drivings.

In the West, and in many other parts of the country where water is bad, where the cost of boiler work is heavy on account of incrustation and scale formation, and where the labor for boiler repairs is hard to get and hard to handle, the use of gas power opens up possibilities of which it is believed progressive men will not be slow to take advantage.

A few years ago the horseless carriage was a subject for jest, and had never been a practical success. Now, nearly every street and highway in the country is more or less populated by automobiles of one kind or another. Perhaps the most successful ones are those operated by internal combustion engines. The stimulation which this industry has given to the development of the gas engine is not inconsiderable.

If the little gasoline engines can drive the heavy automobiles a mile in 52 2-5 seconds, which, I believe, is the best record so far, and if the machines can undertake trips of thousands of miles, it is proper to assume that they have become a permanent factor in transportation. What the final effect of this upon railroad passenger service will be it is hard to predict.

As the manufacturing industries and population of this country grow, the demand for additional power and for fuel for heating and lighting will steadily increase the demand for coal at the mines. Sooner or later we will be forced to take radical steps to economize in the consumption of fuel, which fact must be plain to all of those who can look ahead.

The internal combustion engine holds out the opportunity, and about the only opportunity there is in sight to accomplish this end.

Perhaps it is thought that the locomotive will always have to remain a steam locomotive. It is also believed that this is a field which the internal combustion engine will soon invade, and invade successfully. The inventive genius of the country will surely provide a means of building locomotives with continuous gas producers instead of boilers, and with the internal combustion engine instead of the steam engine underneath them. There is no question in the world but that this can be done, and successfully done with crude oil for fuel, and that such engines will operate for practically 20 to 25 per cent. of the cost of fuel that is now necessary with the steam locomotive, that the boiler repairs will be practically eliminated from among railroad troubles, and is further believed that American genius will also find the way to successfully make gas producers acting continuously which will produce the volume of gas needed for heavy locomotive service as required by the engine without any need for storage.

The internal combustion engine has only recently taken a new lease of life; the great minds of the country have only recently set to work to develop it. Its efficiency to-day can be compared with the efficiency of the steam engine fifty years ago; what its efficiency will be ten years from now can only be guessed, but it is quite likely that it will produce a brake horse-power ultimately for ½ lb. of average grade of coal per hour.

It is quite likely that the future will see coal largely turned into gas right at the pit mouth of the mines and either driven through gas mains to the sources of consumption or by gas engines of great power and dynamos there turn the energy of coal into electricity to be carried off to where power, heat and light are needed, by wire.

TON-MILE STATISTICS OF SWITCHING LOCOMOTIVES.

COMMITTEE—C. H. QUEREAU, G. R. HENDERSON, G. L. FOWLER.

Editor's Note.—This report contains a reprint of a mileage record of switching locomotives taken for the *Railroad Gazette* by Mr. George L. Fowler, and concludes with the following observations:

In view of the care with which these records were taken, the length of time covered in each case and the fairly close agreement of the several records, it seems fair to conclude that the results agree reasonably with the facts. On this basis, three miles an hour for switch engines doing freight work and three and one-half miles an hour for passenger switch engines appear to be a fair credit. If we had equally reliable data as to the average tonnage handled, a comparatively accurate credit of ton-mileage could be proposed, but inasmuch as we know of no such records and the credit would be an arbitrary one, we have thought best to make no recommendation.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION.

ABSTRACT OF REPORTS.—CONTINUED.

CAST-IRON WHEELS.

COMMITTEE—WM. GARSTANG, W. H. LEWIS, WM. APPS, J. J. HENNESSEY.

It will be the intention in this report to eliminate all special or individual conditions and recommend for your consideration what seemed to your committee best to cover the conditions as they now exist. While the time may be ripe for experiments and research along new lines of design and manufacture, the question is certainly too important for this committee to recommend any radical changes without making an expensive series of tests extending over several years and it is the opinion of your committee that experiments of this kind should be carried out solely by the individual members rather than assigned to committee. There were submitted to the committee some twenty different designs of wheels for 60,000, 80,000 and 100,000-lb. cars that were recommended by the wheelmakers or the roads using them, as giving satisfactory service and of which there was no special complaint to be made. After these wheel drawings were made full size on cardboard and cut out, it was surprising to see the difference in contour of the

plates. This naturally raised the question, if the exact lines of plates were of any vital importance or had any effect on the life or wearing qualities of the wheel, and in the opinion of your committee it does not. The subject being interesting and to see what a composite wheel made from all of these good designs would look like, the wheels were grouped and those having the nearest lines plotted one over the other and a composite drawing made. These drawings were again plotted and a representative wheel worked out from them. These final wheels are shown by drawings 1, 2 and 3, and while they might not give any better satisfaction than any of the designs from which they were made they certainly make a very handsome looking wheel and in the opinion of your committee would make a wheel at least equal to the best design now in use and one safe to be followed in making new patterns. These drawings do not show the composite lines for thickness through the throat, or hub lines, of the wheels submitted, but show these lines as recommended by the committee for adoption.

Your committee has gone into the matter of design without being able to come to any conclusion that would justify a reduction in weight without an improvement in the quality of metal used, and the question of quality of material to be used seems to be one that it is absolutely impossible for your committee or those roads not manufacturing their own wheels to control. As mentioned earlier in this report, the special cases where wheels are manufactured at home cannot be taken as a basis for the vast majority, who have to secure their wheels in the open market. Especially is this the case when the wheelmakers advise that any special brand or make of iron that should be specified would only result in a radical increase of price without a corresponding increase in the guarantee. Your committee also believes that a specification of this kind would result in very serious delays and a final acceptance of wheels made of such iron as the manufacturer could secure of grades he has been accustomed to use and which he is willing to guarantee. Therefore the only recommendation governing this point is one limiting the per cent. of scrap to new iron used.

For the reason given your committee recommends the following weights of wheels:

For cars of 60,000 lbs. capacity, 600 lbs.
For cars of 80,000 lbs. capacity, 650 lbs.
For cars of 100,000 lbs. capacity, 700 lbs.

With a minimum weight allowed in interchange of 580, 630 and 680 lbs. and further recommend that all wheels cast in the future have their normal weight cast on the outside plate in figures not less than 1¼ in. long and ⅛ in. high.

It is the further recommendation of your committee that the present wheel specifications be changed to include the weights adopted for wheels for 60,000, 80,000 and 100,000-lb. cars; that they require the normal weight of the wheel cast on the plate in letters not less than 1¼ ins. long; that the amount of old wheels allowed in mixture be not more than 60 per cent. of the total charge. That the chill be not less than ½ in. or more than 1 in. in the tread or throat.

That the drop test be changed to make the test a failure if the wheel cracks, checks or breaks, in the flange, rib or plate, and that the test shall be ten blows of the 140-lb. weight falling 12 ft. for 600-lb. wheels or wheels for 60,000-lb. cars; 13 ft. for 650-lb. wheels or wheels for 80,000 lb. cars, and 14 ft. for 700-lb. wheels or wheels for 100,000-lb. cars.

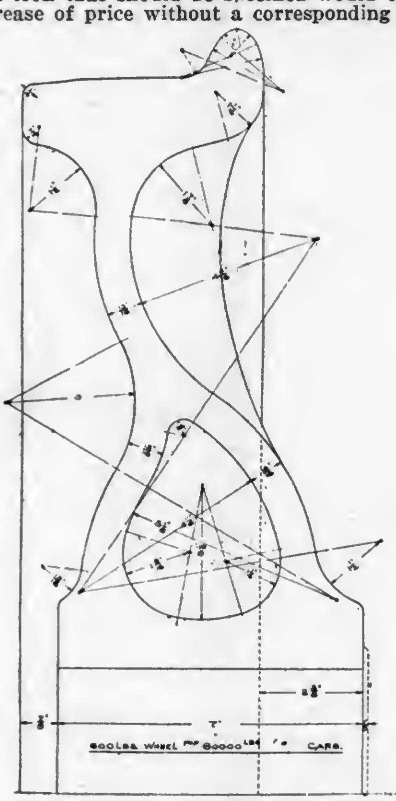


FIG. 1.

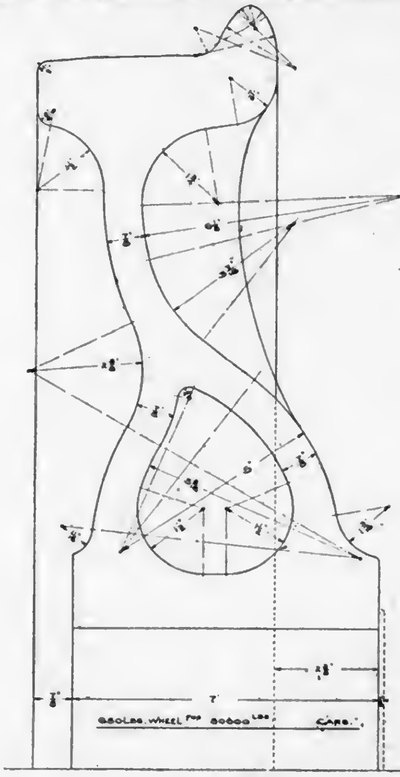


FIG. 2.

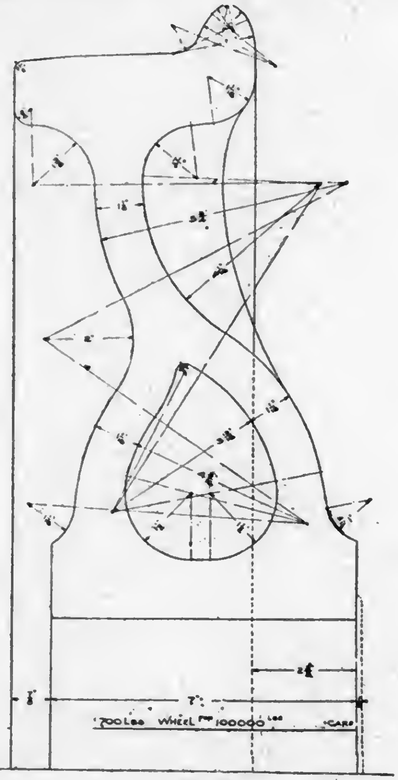


FIG. 3.

STANDARD REQUIREMENTS FOR HIGH-SPEED FOUNDATION BRAKE GEAR FOR PASSENGER SERVICE.

COMMITTEE—F. M. WHYTE, F. H. CLARK, R. N. DURBOROW, J. W. LUTTREL, C. A. SCHROYER.

The Hodge system of levers is shown in the diagrams, and the levers, rods and other parts are calculated for this system; if some other system of levers is used, it is recommended that the calculations be based upon the fundamental data which are given below. The designs have been submitted to the important air-brake manufacturers and have received the endorsements of such manufacturers.

FUNDAMENTALS.

Following are the fundamentals of the design:

Braking power to be 90 per cent. of the light weight of the car.

Equalized pressure in brake cylinder, 60 lbs. per square inch.

Maximum pressure in brake cylinder, 85 lbs. per square inch.

Maximum stress in levers, 23,000 lbs. per square inch.

Maximum stress in rods, except jaws, 15,000 lbs. per square inch; no rod to be less than ⅞ in. in diameter.

Maximum stress in jaws, 10,000 lbs. per square inch.

Maximum shear on pins, 10,000 lbs. per square inch.

Diameter of pins to provide a bearing value not to exceed 23,000 lbs. per square inch.

The reduction of stresses in rods, levers and jaws due to friction of the foundation brake, and the reduction of braking power due to the same cause and to the action of release springs, were neglected because it was considered to be too difficult to determine their value even with a fair degree of accuracy.

SIX-WHEEL TRUCKS.

The committee did not know the weight of the lightest car carried on six-wheel trucks nor the weight of the heaviest, therefore it was assumed that if cars weighing 80,000 lbs. to 137,000 lbs. were properly provided for then the actual limits of weight would be provided for very satisfactorily. The higher limit of 137,000 lbs. was decided upon because certain pins and other parts would need to be increased in diameter in order to fulfil, for heavier cars, the fundamental conditions prescribed in the foregoing. The brake rigging designed for the cars having six-wheel trucks can be used to brake a car weighing 137,000 lbs. to 87.5 per cent. without exceeding the maximum stress prescribed.

The committee submit schedule "A-1" for cars weighing 80,000 to 100,000 lbs. and schedule "A" for cars weighing 100,000 to 137,000 lbs. and having six-wheel trucks; the difference between these schedules is that a 16-in. brake cylinder is to be used for schedule "A" and a 14-in. brake cylinder is to be used for schedule "A-1," otherwise they are the same. The location of the fulcrum hole in the cylinder lever is made to vary by quarters of an inch to suit the weight of the cars, but only one fulcrum hole shall be drilled in each lever.

With schedule "A" there should be used a brake beam suitable for a load of 28,000 lbs., and with schedule "A-1" there should be used a brake beam suitable for a load of 22,000 lbs. imposed at the middle of the beam.

Before deciding to recommend a uniform size of levers, rods and pins for all cars with six-wheel trucks and weighing from 80,000 to 137,000 lbs. there were laid out two brake riggings in accordance with the fundamental data decided upon. One rigging was designed for cars weighing from 80,000 to 100,000 lbs. and the other for cars weighing from 100,000 to 133,000 lbs. and the weights of the parts for each were calculated. It was found that the difference in the weights for the body parts was 57½ lbs. and the difference in weights of parts for two trucks was 67 lbs., a total of 124½ lbs. for one car. It was considered that economy would result from the use of one set of levers, rods, jaws and pins for

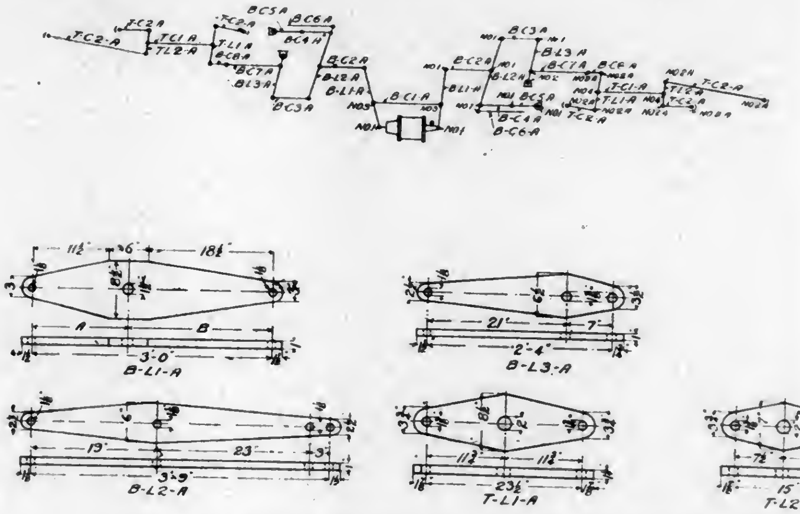


TABLE I
SCHEDULE A-1
FOR CARS WEIGHING 80000 TO 100000 LBS

14" BRAKE CYLINDER CYLINDER LEVER B-L1-A				
FOR CARS WEIGHING	% BRAKE POWER	LEVER NO	A	B
		1	13"	[illegible]
78300 TO 80800	900 TO 875	2	13¼	[illegible]
80900 TO 83200	900 TO 875	3	13½	[illegible]
83300 TO 85700	900 TO 875	4	13¾	22¼
85800 TO 88300	900 TO 875	5	14"	[illegible]
88400 TO 909[illegible]	900 TO 875	6	14¼	21¾
91000 TO 93500	900 TO 875	7	14½	21½
93600 TO 96200	900 TO 876	8	14¾	21¼
96300 TO 99000	900 TO 876	9	15	21
99100 TO 101900	900 TO 875	10	15¼	20¾
		11	15½	20½

TABLE II
SCHEDULE A
FOR CARS WEIGHING 100000 TO 137000 LBS

16" BRAKE CYLINDER CYLINDER LEVER B-L1-A				
FOR CARS WEIGHING	% BRAKE POWER	LEVER NO	A	B
99600 TO 102500	900 TO 874	1	13"	23"
102600 TO 105600	900 TO 87-	2	13¼	22¾
105700 TO 108700	900 TO 875	3	13½	22½
108800 TO 112000	900 TO 875	4	13¾	22¼
112100 TO 115300	900 TO 875	5	14"	22
115400 TO 118700	900 TO 875	6	14¼	21¾
118800 TO 122200	900 TO 875	7	14½	21½
122300 TO 125700	900 TO 875	8	14¾	21¼
125800 TO 129400	900 TO 875	9	15"	21
129500 TO 133100	900 TO 875	10	15¼	20¾
133200 TO 137000	900 TO 875	11	15½	20½

FOUNDATION BRAKE FOR PASSENGER CARS, WITH HIGH-SPEED BRAKES. SCHEDULES A AND A-1.
CARS WEIGHING 80,000 TO 137,000 LBS. 6-WHEEL TRUCKS.

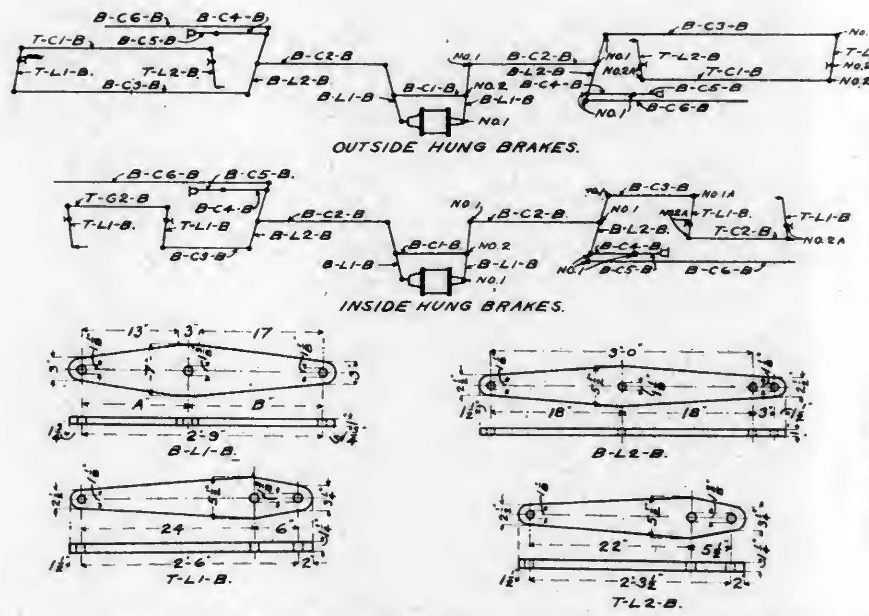


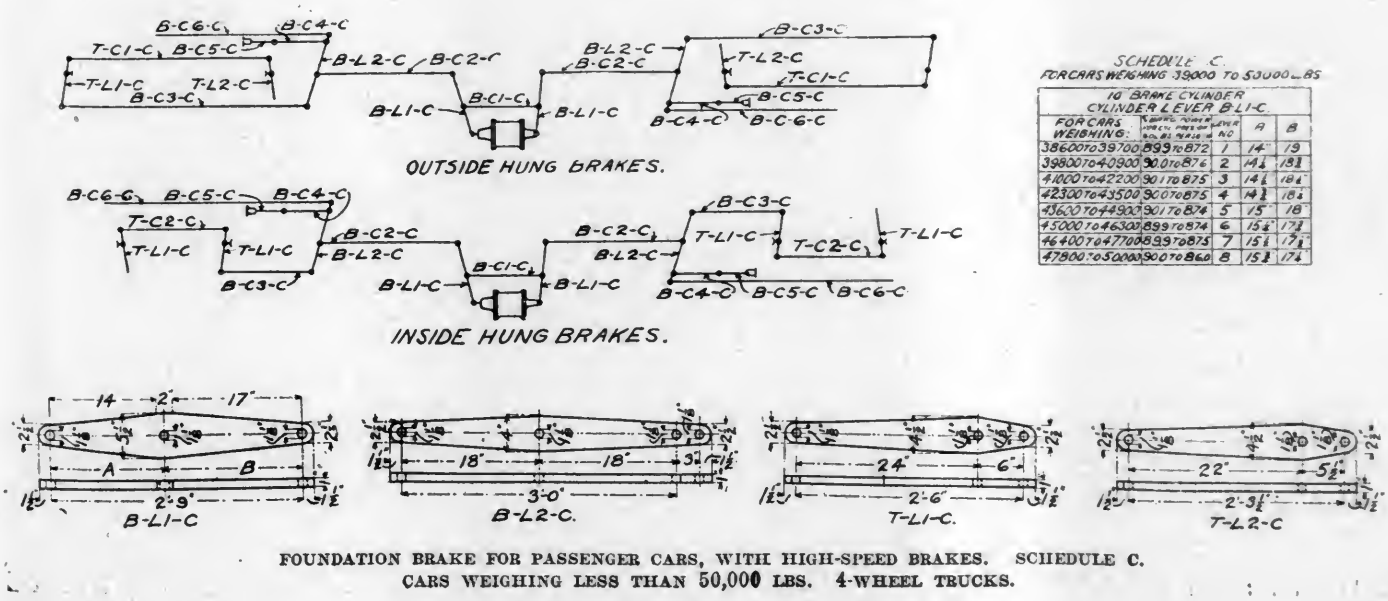
TABLE I
SCHEDULE B-1
FOR CARS WEIGHING 50000 TO 70000 LBS

12" BRAKE CYLINDER CYLINDER LEVER B-L1-B				
FOR CARS WEIGHING:	% BRAKE POWER FOR CYL. PRES. OF 60 LBS PER SQ. IN.	LEVER NO	A	B.
49000 TO 50500	900 TO 873	1	13"	20"
50600 TO 52100	900 TO 874	2	13¼"	19¾"
52200 TO 53700	900 TO 875	3	13½"	19½"
53800 TO 55300	901 TO 876	4	13¾"	19¼"
55400 TO 57200	902 TO 874	5	14"	19"
57300 TO 59000	900 TO 874	6	14¼"	18¾"
59100 TO 60800	898 TO 873	7	14½"	18½"
60900 TO 62700	900 TO 873	8	14¾"	18¼"
62800 TO 64600	900 TO 875	9	15"	18"
64700 TO 66700	900 TO 874	10	15¼"	17¾"
66800 TO 68700	900 TO 875	11	15½	17½"
68800 TO 70800	900 TO 875	12	15¾"	17¼"

TABLE II
SCHEDULE B
FOR CARS WEIGHING 70,000 TO 90000 LBS

14" BRAKE CYLINDER CYLINDER LEVER B-L1-B.				
FOR CARS WEIGHING:	% BRAKE POWER FOR CYL. PRES. OF 60 LBS PER SQ. IN.	LEVER NO.	A	B.
		1	13"	20"
68800 TO 70900	900 TO 874	2	13¼"	19¾"
71000 TO 73200	900 TO 874	3	13½	19½
73300 TO 75500	900 TO 875	4	13¾"	19¼
75600 TO 77900	900 TO 874	5	14"	19"
78000 TO 80300	900 TO 874	6	14¼"	18¾"
80400 TO 82800	900 TO 874	7	14½	18½
82900 TO 85400	900 TO 874	8	14¾"	18¼"
85500 TO 88000	900 TO 875	9	15"	18"
88100 TO 90800	900 TO 874	10	15¼"	17¾

FOUNDATION BRAKE FOR PASSENGER CARS, WITH HIGH-SPEED BRAKES. SCHEDULES B AND B-1.
CARS WEIGHING 50,000 TO 90,000 LBS. 4-WHEEL TRUCKS.



SCHEDULE C.
FOR CARS WEIGHING 39,000 TO 50000 LBS

10" BRAKE CYLINDER CYLINDER LEVER B-L1-C.				
FOR CARS WEIGHING:	% BRAKE POWER FOR CYL. PRES. OF 60 LBS PER SQ. IN.	LEVER NO	A	B
38600 TO 39700	899 TO 872	1	14"	19
39800 TO 40900	900 TO 876	2	14¼	18¾
41000 TO 42200	901 TO 875	3	14½	18½"
42300 TO 43500	900 TO 875	4	14¾	18¼
43600 TO 44900	901 TO 874	5	15"	18"
45000 TO 46300	899 TO 874	6	15¼"	17¾
46400 TO 47700	899 TO 875	7	15½	17½"
47800 TO 50000	900 TO 860	8	15¾	17¼"

FOUNDATION BRAKE FOR PASSENGER CARS, WITH HIGH-SPEED BRAKES. SCHEDULE C.
CARS WEIGHING LESS THAN 50,000 LBS. 4-WHEEL TRUCKS.

all cars having six-wheel trucks and weighing from 80,000 to 137,000 lbs. instead of using two sets of levers, rods, jaws and pins for such cars, and the recommendations correspond with this idea.

FOUR-WHEEL TRUCKS.

The greatest weight of cars equipped with four-wheel trucks was taken as 90,000 lbs. As for the cars having six-wheel trucks, two brake riggings were first designed, one for cars weighing from 50,000 to 70,000 lbs., and one for cars weighing from 70,000 to 88,000 lbs., and the differences in weights of parts were, for body parts 35 lbs., and for parts for two trucks 42 lbs., a total of 77 lbs. Therefore it was considered desirable to recommend one system of levers, rods, jaws and pins for all cars weighing from 50,000 to 90,000 lbs. and having four-wheel trucks.

The brake designed for cars weighing 88,000 lbs. can be used to brake a car weighing 90,800 lbs. to 87.4 per cent. without exceeding the maximum stresses prescribed.

Schedule "B-1" is for cars weighing 50,000 to 70,000 lbs. and having four-wheel trucks, and schedule "B" is for cars weighing from 70,000 to 90,000 lbs. and having four-wheel trucks, the differences between the two being that a 14-in. brake cylinder is to be used with schedule "B," cars weighing 70,000 to 90,00 lbs., and a 12-in. brake cylinder is to be used with schedule "B-1," cars weighing 50,000 to 70,000 lbs.; also that with schedule "B" there should be used a brake beam suitable for a load at the middle of 28,000 lbs., the same as for schedule "A," and with schedule "B-1" there should be used a brake beam suitable for a load at the middle of 22,000 lbs., the same as for schedule "A-1."

The proper braking power for the weight of car is obtained by the location of fulcrum hole in the cylinder lever.

Schedule "C" needs only a few words of explanation. It was designed for cars weighing 50,000 lbs. and less, equipped with four-wheel trucks. A 10-in. brake cylinder is to be used with this schedule and a brake beam suitable for a load at the middle of 15,200 lbs.

PINS AND ROD JAWS.

For all the schedules suggested there be required a total of eight different pins; one of the pins is a present M. C. B. Standard. Of the eight there are four different diameters. The pins are numbered. There are ten different rod jaws required for all the schedules and these are made of four different sizes of iron.

DESIGNATION OF RODS AND LEVERS.

On the drawings, the location of levers and rods are designated by letters, the first letter in the designation distinguishes between body and truck. The second letter distinguishes between the levers and the connections. The figure following the second letter is the distinctive number for the lever or connection; and following this figure is the schedule letter to which the lever or connection belongs. Thus B-C2-B means body connection number two (second from cylinder piston rod), of schedule "B"; also T-L2-B would mean truck lever number two for schedule "B."

TABLE I.

Schedule designation.	Light weights of cars. (Lbs.)	Type of truck.	Size of brake cylinder.	Maximum load at middle of brake beam.
A.	100,000 to 137,000	6-wheel	16 ins.	28,000 lbs.
A-1.	80,000 to 100,000	6-wheel	14 ins.	22,000 lbs.
B.	70,000 to 90,000	4-wheel	14 ins.	28,000 lbs.
B-1.	50,000 to 70,000	4-wheel	12 ins.	22,000 lbs.
C.	50,000 and less.	4-wheel	10 ins.	15,200 lbs.

There have been brought together in Table I. the distinctive data of each schedule so that by referring to the table the correct schedule for any particular car may be found quickly.

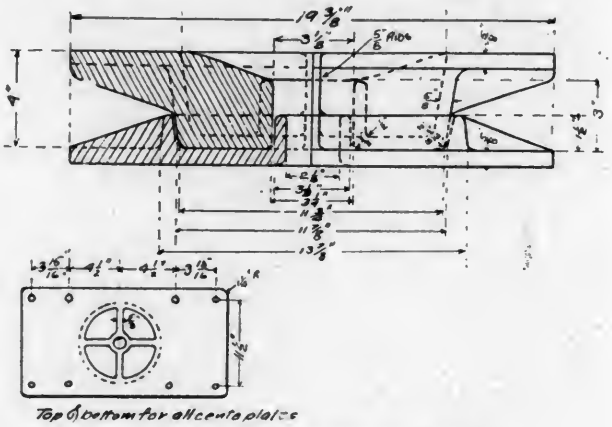
SIDE BEARINGS AND CENTER PLATES.

Committee—T. W. Demarest, A. E. Benson, J. W. Luttrell, G. N. Dow.

In summing up the results obtained, the minimum flange resistance was obtained with the flat plate, "Form A," of chilled cast iron. The projected area of this plate was 100.14 sq. ins. In order to determine the best size of this plate, six different plates were constructed, ranging in area from 100.14 sq. ins. to 46.793 sq. ins. The results obtained, as noted in the tables and on the cards, are so close that it is difficult to say which will be the best area to adopt. Apparently, the flat plate with an area of 86.738 sq. ins., using as a basis a smooth casting, no lubrication, gave the best general results, and a flat plate of this description is recommended to the association as the standard form of center plate.

It will be noted also that two ball bearing center plates were tried. These center plates gave such remarkable results that there can be no question of a reduction in flange resistance by their use. One road has been using for a number of years now a ball bearing center plate, and in so far as durability is concerned, the plates are reported as giving entire satisfaction. It is recommended to the association that during the coming year the members equip a number of cars with ball bearing center plates, in order to ascertain more fully their durability.

A number of side bearings were also tried, but these experiments could not be completed, as, in order to test the different makes, it would have been necessary to reconstruct the machine, which time would not permit. In so far as the tests were carried out, however, the results indicate very much less flange resistance with the roller side bearings than with the ordinary flat cast iron plate. On account of the inability to thoroughly test out the side bearings, the recommended distance from center of center plate to center line of side bearing was not obtained. Replies from various members of



RECOMMENDED FORM OF CENTER PLATE.

the association indicate this distance to run from 24 to 32½ ins. In the tests as conducted the distance was taken as 25 ins.

While the committee recommends to the association a standard form of center plate, as Plate "A," there is no doubt in the minds of the committee that if the ball bearing center plates and side bearings are durable in service a very greatly decreased flange resistance will be obtained.

GOLD CAR HEATING & LIGHTING COMPANY.

The amount of Gold heating apparatus sold during the past year was nearly double that of any former year since the origin of this business. Not only has the tremendous increase taken place in its steam railway car heating department, but the electric heating branch has developed and improved very materially as well.

The trade of this company is increasing continually. During the past three months the number of cars and locomotives for which orders for heating equipment have been received has been very gratifying. Among others, it is interesting to note that a few of the orders recently taken by the Gold Company for cars, locomotive and electric car heating equipment are as follows:

	Equipments.
Canadian Pacific	290
Brooklyn Heights Railroad	240
Missouri Pacific	125
Wabash	105
Erie	102
New York, New Haven & Hartford	101
Massachusetts Electric Companies	100
Metropolitan Street Railway	100
Southern	79
Louisville Railway	75
Central Railroad of New Jersey	58
New York Central & Hudson River	45
New Orleans & Northeastern	40
Boston & Albany	37
Cleveland, Cincinnati, Chicago & St. Louis	36
Denver & Rio Grande	35
Chicago & Eastern Illinois	32
Western Maryland	21
South Side Elevated	20
Scranton Railway	15
Nashville, Chattanooga & St. Louis	21
M., St. P. & S. S. M.	22
Cincinnati, Hamilton & Dayton	12
Texas & Pacific	24
Georgia Railroad	4
Lake Shore & Michigan Southern	15
Boston & Maine	28
New York, Ontario & Western	14
Delaware, Lackawanna & Western	25
Chesapeake & Ohio	5
Atlanta & West Point	6
Central of Georgia	14
Alabama Great Southern	4
Cincinnati, New Orleans & Texas Pacific	14
Vicksburg, Shreveport & Pacific	8
Alabama & Vicksburg	6
Mobile & Ohio	15
Louisville & Nashville	3

The above are but a few of the many contracts received within the last few months. As a matter of fact, during the short period mentioned the company has sold nearly 4,000 sets of its heating equipment in the United States alone. During the past month an order has also been received for the shipment of several thousand sets of its specialties abroad.

A short time ago a contract was closed with the Atlantic Coast Line to cover the use of Gold Car Heating and Lighting Company's system on all of the passenger cars and locomotives of the Atlantic Coast Line, Plant System and the Charleston & Western Carolina.

Within the past few days the New York Central & Hudson River Railroad, together with the Lake Shore Railway, and the lines which they operate, decided to adopt the company's improved large ... e Gold straight port steam coupler for use on all of their cars and locomotives.

The unfilled contracts on the books of the Gold Company at the present time are larger than ever before in its history. At the last meeting of directors the regular quarterly dividend of 2 per cent., together with an extra dividend of 9 per cent., was declared. All ... the company's devices have been improved from time to time, and in their latest systems many ingenious and valuable features are apparent and most highly commended. The very general adoption of its car, locomotive and electric heating apparatus all over the world where modern appliances of this kind are used, speaks volumes for the merit of the Improved Gold Systems of Car Heating. The main office of Gold Car Heating and Lighting Company is at Frankfort and Cliffs streets, New York City. The other offices of the company are at Chicago and London.

A STUDY OF ALLOYS FOR BEARING PURPOSES.

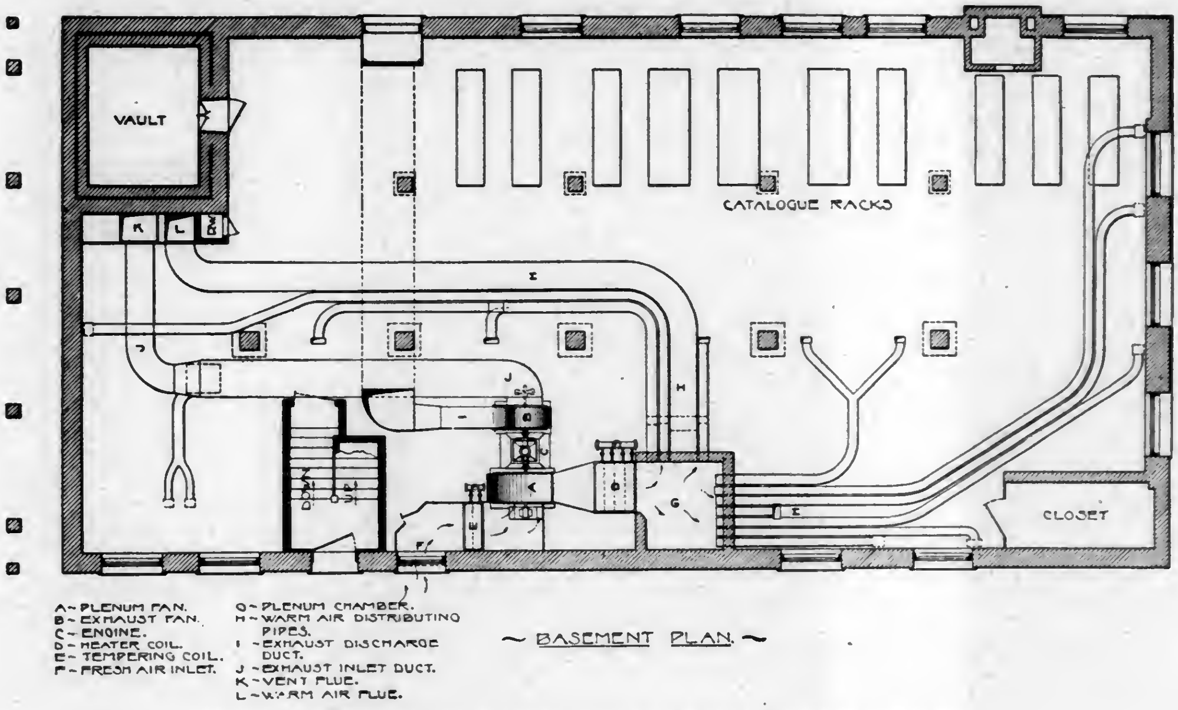
In an admirable paper on this subject read before the Franklin Institute, Mr. G. H. Clamer, of the Ajax Metal Company, Philadelphia, presented an interesting study of white metals and bronzes. He described tests, discussed various proportions of bronzes and showed how his investigations corroborated other well-known authorities. As a result of much experimenting a new alloy was developed, concerning which he made the important statements given below. Readers are referred to the paper itself for the complete discussion.

"This alloy is now known in the trade as 'Plastic Bronze,' and has become a thoroughly commercial article. It has been on the market hardly three years, but has been made in an amount which approximates 4,000,000 lbs. It has been cast in all manner of patterns, weighing from a fraction of a pound to over 1,000 lbs. each, and is handled as readily in the foundry as phosphor bronze, manganese bronze or any of the more common alloys. Castings are sharp and clean. It machines readily, and, in fact, possesses all the qualifications essential for practical purposes.

"Having accomplished the production of an alloy containing upwards of 20 per cent. lead, the next object was to test it in the manner of the previous ones, the tin being kept constant at 5 per cent.

"The alloy which we have adopted consistent with proper strength for general purposes and with the best foundry results is: Copper, 64 per cent.; tin, 5 per cent.; lead, 30 per cent., and nickel, 1 per cent.

"It will be noted that what is true of the alloys of 15 per cent. lead and under, as examined by Dr. Dudley, is also true of the high-lead-content alloys, viz: that the rate of wear diminishes with increase of lead, or, in other words, the rate of wear diminishes with the diminishing compressive strength or increased plasticity of the alloy. This alloy has plasticity resembling Babbitt metals, and for this reason can fairly be expected to show a less tendency to become heated. This has been amply proven in actual service."



VENTILATING AND HEATING SYSTEM.—OFFICES AMERICAN BLOWER COMPANY.

AMERICAN BLOWER COMPANY'S NEW OFFICE BUILDING.

Heating and Ventilating System.

The accompanying cuts show the spacious new office building of the American Blower Company of Detroit, Mich. The business of this company has increased so rapidly during the past two years that the old offices, which occupied valuable space in one of the factory buildings, became entirely inadequate to accommodate the increased office force.

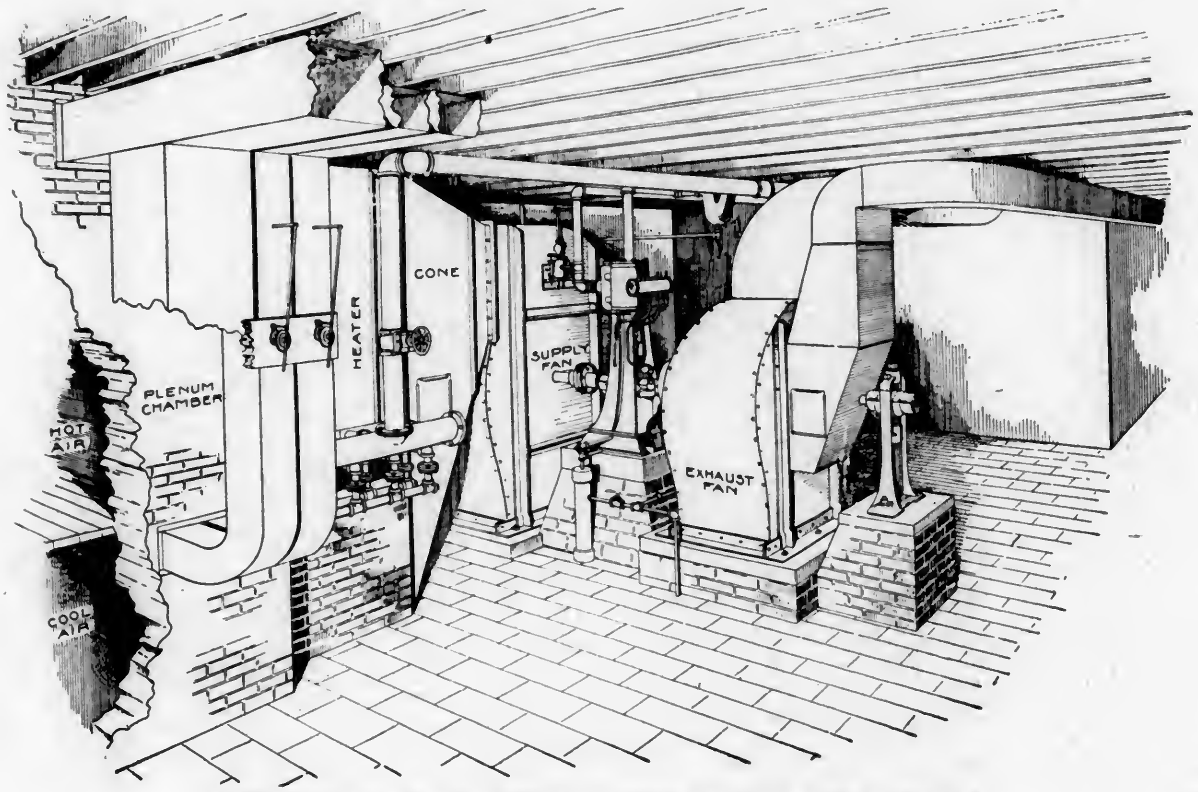
The first floor is occupied entirely by the different commercial departments, while the second floor is used by the engineering and drafting departments. The basement is used for the storage of catalogues, letter files, etc. The blue-print and dark room are provided for on the roof, being located in that position to secure the best light for sun printing.

The main interest in the equipment of this building is in the mechanical system of heating and ventilating. As the manufacture of heating and ventilating apparatus forms a large part of the American Blower Company's business, this part of the office equipment naturally received due attention. The apparatus is located at one side of the basement as shown on the accompanying plan. The fresh air enters the building through the basement window F and by means of the fan A is drawn over a coil of pipes, E, called the tempering coil. The steam pipes in this tempering coil are just sufficient in number and length to heat the volume of entering air to a temperature of 65 or 70 degs. The fresh air is then drawn into the fan and forced over another heater, D. This is the main heater and is designed to heat the air to about 140 degs. Beyond the heater is located a large brick chamber, C, called the plenum chamber. This serves as a reservoir for the heated air, and from this chamber the air is conveyed by galvanized iron pipes, H, to the various offices. Under the main heater, D, is a passage or by-pass, as it is called, which permits a part of the air from the fan to pass under the main heater coil and into the plenum chamber. This passes into the lower section

of the plenum chamber, which is separated from the upper part. Thus the plenum chamber is divided into two parts, as shown by accompanying sectional elevation, the upper chamber containing hot air at approximately 140 degs. and the lower section tempered air at 70 degs. As shown by this sectional view, each individual pipe leading off to the offices above has two connections to this plenum chamber, one branch to the upper section and another to the lower. In each main where the pipe divides into these two sections there is located a set of double swinging dampers, or mixing dampers. Each set of these dampers is controlled automatically by a diaphragm valve shown on the outside of the pipe in the sectional view. These automatic valves are part of a system of automatic heat control which was furnished by the Johnson Electric Service Company, of Milwaukee, Wis. These valves are operated by compressed air, which is supplied by a small air compressor located in the basement. This compressor works by city water pressure and delivers air at about 15 lbs. pressure. On the expansion or contraction of a piece of brass and steel in the thermostat, air pressure is admitted or cut off from the diaphragm valve and the mixing dampers are swung one way or the other, as the case may be. It will be noted that these mixing dampers in swinging do not cut off the flow of air, but simply vary the proportion of hot and tempered air as controlled by the thermostat to maintain a constant temperature in the room. Thus a constant flow of pure air of the proper temperature is maintained at all times. Under the tempering coil there is also a by-pass similar to the one under the main heater. This by-pass is fitted with a swinging damper, which is controlled by a thermostat placed in the upper part of the plenum chamber. Thus if the air in the plenum chamber becomes too hot, the thermostat opens the damper under the tempering coil and allows the entering air to pass under the tempering coil instead of through it. The air is admitted to each room at a point of about 8 ft. above the floor.

The fan is operated by a direct-connected vertical engine. This engine is also the American Blower Company's own make and is specially designed for this class of work. Another unique feature of this plant is the exhaust fan, which is direct-coupled to the same engine which runs the heating fan and which draws the impure or vitiated air out of the building. Thus while one fan is discharging pure warm air into the building the other fan on the same shaft is drawing out the impure air. This is the main feature of mechanical ventilation which has brought it into such general favor during the last few years for use in public buildings.

The condensation from the heating apparatus is returned to a Webster feed-water heater located in the engine room of the factory. This same system handles all the condensation from two other heating plants located in the factory. The advantage of this vacuum system is that it eliminates the back pressure from the factory engine when using exhaust steam for heating and also removes the air from the heating coils and connecting pipes as fast as it accumulates, thus making the heating surface far more effective than it otherwise would be.



VENTILATING AND HEATING SYSTEM.—OFFICES AMERICAN BLOWER COMPANY.

MOGUL METAL.

The T. H. Symington Company use a metal for their journal boxes, of which a description has been received which is condensed as follows:

The crystalline structure, heat treatment and condition of the carbon content are factors of the greatest moment in iron and steel. In a long period of experimental work this company has sought a metal which would have sufficient density, close crystalline structure, high resilience and at the same time maintain the fine wearing qualities of cast iron "which are noticeably absent in malleable iron. The results obtained are so wonderful and far-reaching that we have practically produced a new metal, which we have named 'Mogul Metal,' which has all of the above desired characteristics and is an absolutely certain obtainable product."

"Ferrite" is practically pure iron and, except graphite, is the softest constituent of cast iron products. Ferrite is iron practically free from carbon, though it may contain other impurities. Fig. 1 illustrates the appearance of ferrite as it would appear under a powerful microscope, the lines representing the divisions into crystals. "Cementite" is the hardest constituent of iron or steel and is a definite carbide of iron. It does not occur by itself, but is found in thin layers which are straight or curved and alternating with thin layers of fer-

r..e. These layers together are known as "pearlite." With the f..st increment of carbon in wrought iron pearlite forms in t.e corners or angles of the crystals and has the form indic..ted in Fig. 2. With about 0.8 per cent of carbon the pearlite ..s the appearance of Fig. 3. With more carbon than this the t.ee cementite appears as shown in Fig. 4, and as it increases ..e free cementite entirely surrounds the crystals and the p..arlite becomes immersed in free cementite. The carbon ..hich exists in the mass as free cementite and pearlite may ..e entirely changed by heat treatment into the form of small ..articles of free carbon uniformly distributed throughout the mass of ferrite which is simultaneously formed and is illus..rated by Fig. 5. In this form the carbon known as "temper

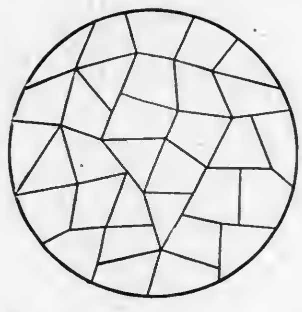


Figure One—Ferrite crystals containing no carbon.

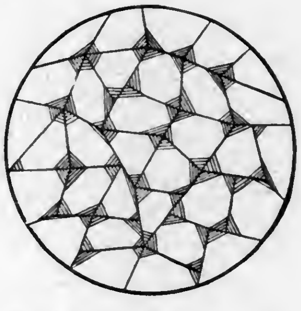


Figure Two—Ferrite crystals with less than .8 per cent. carbon in form of Pearlite.

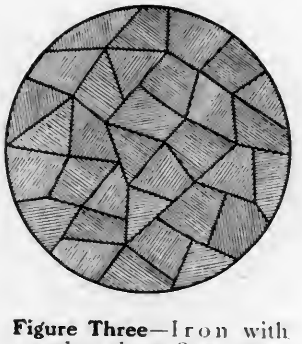


Figure Three—Iron with carbon about .8 per cent., all in form of Pearlite.

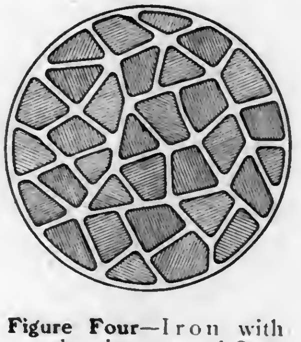


Figure Four—Iron with carbon in excess of .8 per cent., showing Pearlite and free Cementite.

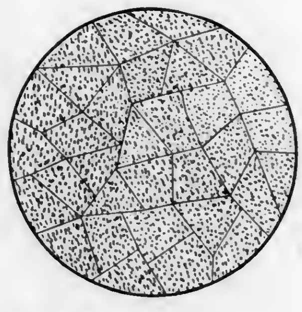


Figure Five—Iron in which Pearlite and free Cementite has been broken up by heat treatment into the form of Temper Carbon.

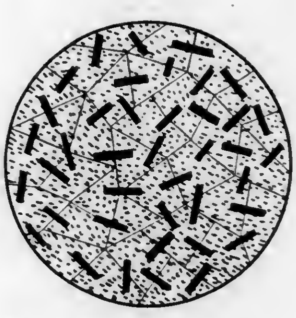


Figure Six—Iron in which Pearlite and free Cementite has been broken up by heat treatment into Temper Carbon, also showing the manner in which Graphitic Carbon exists throughout the mass in cast iron.

DIAGRAMS REPRESENTING STRUCTURE OF CAST IRON.

carbon" exists in minute holes in the ferrite crystals and does not destroy the ductility of the ferrite. This structure is somewhat similar to common commercial malleable iron. The way graphite exists in iron is illustrated in Fig. 6, where the black irregular portions are graphite imbedded in metal in which combined carbon or cementite has been, by heat treatment, thrown into the uniformly distributed temper carbon as illustrated in Fig. 5. "Our great aim is, as far as possible, to control the size of the particles of graphite carbon. To produce the desired structure we must absolutely control the amount and size of graphite carbon in our casting."

What is sought in "Mogul Metal" is wearing qualities superior to the best gray iron, and far superior to malleable iron. The control mentioned is obtained by a special mixture and by the use of ingredients found to have a remarkable and peculiar effect on the graphite and other elements, phosphorus, silicon, sulphur and manganese, and, further, by the heat treatment. Having developed this process, this company uses this metal with "certainty that it will meet the demands of hard railroad usage. The metal has about the same tensile strength as good malleable iron, but is not quite so ductile. It can be slightly bent, but cannot be mashed out of shape without breaking." This new metal is advocated because it will hold its shape and, furthermore, it has a high scrap value, and its weight is about the same as malleable iron. The general offices of the T. H. Symington Company are in the Calvert Building, Baltimore, Md.

Mr. Norton A. Mears has been appointed storekeeper of the Indiana, Illinois & Iowa Railroad at Kankakee, Ill.

BOOKS AND PAMPHLETS.

The Car Builders' Dictionary, 1903. An Illustrated Vocabulary of Terms Which Designate American Railroad Cars, Their Parts, Attachments and Details of Construction. Compiled for the Master Car Builders' Association by Rodney Hitt. Illustrated, bound in leather. Published by the *Railroad Gazette*, 83 Fulton street, New York. Price, $5.00.

The first edition of this indispensable book was published in 1879, the second edition appeared in 1884, the third in 1895, and the present volume surpasses the others in every respect. It not only brings the subject up to date, but its general character in every particular is notably better. The standard of the present volume will be difficult to improve upon. The original purpose was to standardize the terms of car construction. This has given the work a powerful influence in the actual standardization of construction itself, so that the consummation of a standard car seems to be a possibility. It is to be hoped that the next edition will contain detail drawings of a standard car. The present volume gives evidence of most intelligent selection of subjects for illustration. The general plan of arrangement is not changed, but there are fewer engravings. The value of the book is increased by this, because only construction of proved merit and approved practice is included. Steel cars and improved draft gears naturally occupy a large amount of space. These have come into prominence since the appearance of the previous volume, and the treatment accorded them is a record of progress in new lines. By use of half-tones and line engravings, photographic views, floor plans, framing plans and sections of wooden and steel cars are shown in sufficient numbers to cover all requirements of reference, and the details of car furnishings and equipment are presented in a great variety. The book is not disappointing in any particular. Special mention should be made of the uniformly excellent line engravings. Our readers, being familiar with the earlier editions, will lose no time in securing copies of this one. Those who do not know the book need only be told that it affords a liberal education in the subject of cars and the standards of the M. C. B. Association. It is a pleasure for the reviewer to compliment the editor and publishers upon the satisfactory result of this difficult undertaking.

Railroad Construction: Theory and Practice. A Text-Book for the Use of Students in Colleges and Technical Schools. By Walter Loring Webb, C.E., Assoc. M., A. S. C. E., formerly assistant professor of civil engineering, University of Pennsylvania. Second edition, reset and enlarged. 675 pages. John Wiley & Son, 43 East Nineteenth street, New York. 1903. Price, $5.00.

The book in its revised edition is in pocket form and the material of the early edition is retained very largely in its original form, except in size of page. There are added, however, about 200 pages of new matter, which should make it of greater value for the purpose intended, as stated in the preface. "The author's aim has been to produce a text-book for students, and the subject matter has therefore been cut down to that which may properly be required of students in the time usually allotted to railroad work in a civil engineering curriculum." About 100 of the new pages treat of miscellaneous structures and buildings, yards and terminals, block signalling, rolling stock, train resistance, cost of railroads, the last of which is generally convenient and has especial value in connection with the treatment of the cost of items of

earthwork contained in the original book. Another 100 pages are devoted to railroad economics, treating of operating expenses and their effect upon changes in distance, curvature, rise and fall (although not so named), grades, ruling, pusher and balanced for unequal traffic, and the improvement of old lines. It is no discredit to Mr. Webb that he acknowledges closely following Wellington's treatment of the subject, for this seems yet the proper thing to do. The preface says: "Those who are familiar with the late Mr. Wellington's masterpiece, 'The Economic Theory of Railroad Location,' will readily appreciate the author's indebtedness to that work. The author has developed the theory on an independent basis, with the exception of a few minor details." It is not improbable that many engineers in railroad practice will be glad to look into the subject through the 100 pages used here, rather than attempt the larger and much more difficult task of picking out what they need from a larger book. The book is bound in morocco with a flap. The typography of the thirteen tables included is very good, and the book in its new dress is more useful for the people who would use it and is attractive in appearance generally.

Notes on Track Construction and Maintenance. By W. M. Camp, editor *Railway and Engineering Review.* 1,214 pages; 620 engravings. Published by the author at Auburn Park, Chicago, Ill. Price, $3.00. Printed in two volumes for foreign distribution: price, $3.50.

This is the most complete and comprehensive book ever written on the subject of track. The object of the author was to write simply enough for trackmen and thoroughly enough for engineers. The work was done with extraordinary care and conscientious patience, with the intention of bringing the entire subject up to date with particular reference to satisfactory construction and labor-saving machinery employed in track and road building. The author is a master of his subject, having been a trackman and afterward an educated engineer. In such a work the personal opinions of the author may not agree with those of all his readers, but these are set forth in this case as those of a man who has worked his way through all the grades of the track department. Mr. Camp does not hesitate to take issue with the report of the Master Mechanics' Association committee of 1900 on the subject of flanges on driving wheels, and, among other parts of the book, this will specially interest mechanical officers. The author's comments on this subject direct attention to the need of more co-operation between the various departments interested in such a subject as this, because there are many matters of this kind which affect both track and rolling stock. Some portions of the book seem to be unnecessary repetitions of the work of others—such as problems in switch work and curves. These, however, are probably included for the benefit of those who may not be supplied with hand-books on these subjects. The chapters are as follows: Track Foundation, Track Materials, Track Laying, Ballasting, Curves, Switching Arrangements and Appliances, Track Maintenance, Double Tracking, Track Tools, Work Trains, Miscellaneous, Organization and Supplementary Notes and Tables. It is a very valuable book on a most important subject and is treated from the standpoint of one who knows the difficulties which a so-called practical man must face in the pursuit of information and who also knows the difficulties which the engineer faces in his use of information which he has. The work was brought out serially in the *Railway and Engineering Review*, appearing in 154 articles. They have been revised, 80 of them being re-written, the book having 70 per cent. more reading matter added to the original. It is a book which every railroad officer in the operating, maintenance of way and mechanical departments should own and use.

Proportions and Movement of Slide Valves. By W. D. Wansbrough. 1903. D. Van Nostrand Co., Warren street, New York.

This volume of 160 pages contains in convenient form the articles by the author on this subject which have appeared serially in the pages of the *Mechanical World.* The author gives the credit for the invention of the slide valve to Murdoch, the pupil and assistant of Watt. The book opens with a number of studies of the functions of valves. The other chapters discuss double slide valves, expansion plates, and Meyer gear. Liberal use is made of valve diagrams. The book should be valuable to the designers of stationary engines.

Proceedings of the American Railway Association from 1899 to 1902, inclusive. Published by the association, 32 Park Place, New York. Price $5.

This is the third bound volume of the proceedings of this important organization, edited by the secretary, placing the reports and discussions in convenient form before those who desire to preserve this record. The index is unique in that it presents in the form of carefully prepared abstracts the most important work of the association. By referring to the index the busy reader will usually find all that he requires, and the text of the reports and discussions is easily found for complete reference. The book has over 1,000 pages. It is a large volume, and does not appear to have been abridged. It contains the semi-annual volumes which have been distributed in pamphlet form after each meeting of the association.

Metallic Packings. By Charles Longstreth. Reprint of a paper from the journal of the American Society of Naval Engineers, Vol. XV., No. 2.

Mr. Longstreth has conferred a favor upon engineers and users of metallic packing by this discussion of the principles of design essential for successful development of packing. The paper briefly discusses the early history of the subject, points out the purposes and requisites of satisfactory packing, and proceeds to present the characteristics necessary to meet the requirements of various kinds of service. Rigid and flexible forms are described, and special attention is given to the conical ring type of flexible packings which are in use on 90 per cent. of the locomotives running in the United States. It is made clear that engine efficiency is greatly dependent upon the character of packing used, and that most careful attention to efficient maintenance is absolutely necessary. By occasional references to locomotive practice as a field where maintenance is not all that could be desired, and by citing a record of ten years' service in marine practice, the author throws a side light upon a condition of the packing question on railroads which motive-power men would do well to consider most carefully. The paper shows the destructive effect of water on metallic packings and indicates the proper method of fitting up and maintaining them. Presumably copies of the paper may be had from Mr. Longstreth, 427 North Thirteenth street, Philadelphia.

Characteristic Facts About Trees.—How trees that are supposed to be familiar to everyone—like the pine and the oak—have beauties that are unnoticed by the ordinary observer will be shown, it is said, in some remarkable photographs taken by J. Horace McFarland to illustrate his forthcoming "Book of Trees." The author, besides being an ardent lover and an earnest student of nature, is an unusually expert photographer, and it is believed this work will show what is characteristic and beautiful about the trees as species and as individuals. The Outlook Company have the work in preparation, and believe that it will be ready by early fall.

Specifications for Material and Workmanship for Steel Structures.—The specifications adopted this year by the American Railway Maintenance of Way Association have been issued in pamphlet form. Copies may be had from the secretary, Mr. L. C. Fritch, room 1562, Monadnock Block, Chicago. Price 10 cents.

"Nature's Insulation" is the title of an exceptionally fine pamphlet issued by Messrs. Baeder, Adamson & Co., 730 Market street, Philadelphia, Pa., describing improved methods of insulation, using hair felt, for cold storage and other forms of refrigeration. The pamphlet was prepared by Mr. H. J. Bellman, who is in charge of the hair felt department of this company, and it is altogether the best work of the kind that we have seen. No one who is interested in the subject will lay the pamphlet aside without reading it clear through. It opens with a statement of the impossibility of perfect insulation and the reasons why nature's insulation, hair, is the best and most permanent material available. Hair owes its superior qualities to the air held mechanically by the fibers and retained motionless, "dead air" being the best non-conductor known. The second chapter deals with convection, conduction and radiation, illustrated by diagrams, and here is shown the importance of guarding against the destruction of the effectiveness of insulation by moisture. Proper stress is laid upon the fact that good insulation means a reduction of operating expense because poor insulation involves more refrigeration or more ice. Experience and investigation have taught the superior value of spaces filled with the right material over hollow construction confining air in spaces wherein it may move about. Results of experience and extensive experiments are given on page 23. It is shown that hair felt is twice as effective as mill shavings or mineral wool. This appears in the cost of construction and the space required for the insulation. This is very important in ship and car refrigeration. The descriptive por-

ion of the pamphlet closes with a statement concerning the manufacture of hair felt. It is made from selected cattle hair received direct from the tanners and thoroughly washed, picked and dried. Hair felt is put up an rolls of various widths and from 1/4 to 2 ins. thick. Illustrations in colors show approved methods of application to refrigerators, cold storage spaces and refrigerator cars, also photographic reproductions of cars, cold storage warehouses and ships equipped with this insulation are included. This company has a record of seventy-five years in this product, which entitles them to thorough confidence.

The Watson-Stillman Co., 204 East Forty-third street, New York, issue catalogue literature in accordance with a unique and very convenient plan. The Illustrated Index for 1903, known as Catalogue No. 65, has just been received. Its purpose is to show in a medium-sized book the great variety of tools manufactured by this company. It is a pamphlet of 72 pages of illustrations, each engraving representing from one to twenty sizes of tools, and complete descriptions are available in the form of loose sheets. These sheets are bound in neat covers in various combinations to suit the demands of various correspondents, according to the special line of business for which hydraulic machinery is required. It would be impracticable to issue a single bound volume to include all, and the present scheme comprises seventeen sectional catalogues, of which eleven are in print and ready for issue, six being in manuscript or in unbound assortments. The index gives a key to all, and the one just issued replaces that of about four years ago. The present one has 72 pages of illustrations, being an increase of 28 pages, with additions in all departments. The pages are numbered, also the sheets giving detailed information, and it is easy for a purchaser to secure exactly the desired information. The pamphlet closes with an index of illustrated sheets. The engravings are all finely executed wood cuts. An examination of the pamphlet gives the impression of an extraordinary increase in the scope of hydraulic apparatus in manufacturing processes.

Two new circulars have been received from the Chicago Pneumatic Tool Company. These are advance sheets of a new catalogue. One is devoted to pneumatic drills. It illustrates Little Giant drills, flue-rolling, reaming, tapping, wood-boring machines and the Boyer piston air drill. A number of attachments for the drills are also shown, such as angle gears, flue cutters and flue expanders. The pamphlet closes with a statement of results of tests made with these machines, which illustrate tneir advantages over hand work. The other circular illustrates and describes pneumatic hammers and riveters. It includes valuable tables illustrating the possibilities of reducing the cost of work by their use. Such records are very seldom seen in catalogues. We have also just received special circulars Nos. 38 and 39, illustrating various types of pneumatic tools, with views of the tools at work. Special attention is directed to applications of the Boyer drill and "jam riveter," a new method for cleaning locomotive crown sheets with the riveter and of applying the Boyer drill to a yoke similar to those used in riveting. These are important functions of air tools believed to be entirely new, and are sure to find a good reception in locomotive shops.

"A Review of Technical Points for the Protection of Metal Surfaces" is the title of a pamphlet written by Mr. W. H. Loomis and issued by the National Paint Works, Williamsport, Pa. The author bases his opinion on an experience of twenty years, and the pamphlet contains references to many of the best known authorities on paints. The arguments in favor of oxide of iron paints include this: "The tin roof on old Independence Hall in Philadelphia, Pa., has been preserved for the past 130 years with an oxide of iron paint, which is conclusive argument for the pigments." Dr. C. B. Dudley, of the Pennsylvania Railroad, is quoted as follows: "We are quite free to confess that in our experience we have not been able to confirm the common belief among paint manufacturers, and indeed among many of the users, that the oil is the life of the paint. The *pigment* is the life of the paint, according to our experience." The pamphlet contains statements of great value to railroad men, and particularly to those who are anxious about the corrosion of steel cars. It contains numerous records of experience with paint on railroad structures.

Furguson Oil Furnaces.—A new catalogue has been issued by the Railway Materials Company, Old Colony Building, Chicago, illustrating these furnaces and showing their advantages for railroad shops and manufacturing plants. Opening with a brief statement of the peculiar adaptability of oil to heating furnaces and of the commercial savings made possible, the pamphlet presents excellent engravings, both from photographs and line drawings, illustrating fourteen styles of oil furnaces such as are used very successfully in the best and most modern railroad shops. These include small furnaces for flue welding and rivet heating, larger furnaces for forging and bulldozer work, for case-hardening spring work, and still larger ones for flanging and annealing of plates. The pamphlet closes with engravings of Furguson portable heaters and fire kindlers. In connection with the equipment of the Collinwood shops of the Lake Shore we shall refer to these furnaces again.

"Colors and Specifications" is the title of a handsome six-page folder issued by the Joseph Dixon Crucible Company, Jersey City, N. J. Five excellent examples of steel construction are illustrated. The specifications suggest best methods of construction and maintenance of steel structures by paint and are based upon forty years of successful experience. The folder also exhibits the four shades of Dixon's silicon-graphite paint manufactured by this company.

Exhaust Fans.—A new catalogue, No. 149, has been issued by the American Blower Company, Detroit, Mich. It is devoted to the "A. B. C." exhaust fan for the removal and conveying of shavings and dust, the removal of smoke and for use in connection with heating and drying apparatus. The pamphlet also presents dust separators, dry kiln equipment, and includes convenient tables of information.

The Jeffrey Manufacturing Company, Columbus, Ohio, have issued Catalogue No. 19, illustrating coal cutters and coal drills, operated by electricity and compressed air; electric locomotives for mine and surface haulage, and complete electric power plants for mining properties. It is a finely illustrated pamphlet of 127 pages, showing a very large variety of this equipment and giving information for its use.

A NEW LIQUID GLUE.

A new and remarkable adhesive known as Army and Navy Glue attracted attention at the recent conventions at Saratoga. It is a liquid glue, but is not derived in any way from fish. The inventor, J. W. Wachter, a leather worker, in the employ of the United States Government at Washington, produced it in an effort to secure a more satisfactory adhesive than those previously available. As a result he produced a glue which is satisfactory for leather, wood and other gluing, and one which sustained a weight of 327 lbs. per sq. in. of surface of steel bars glued to each other. Having occasion to encase some shells with leather, Mr. Wachter used this glue, and though the shells weighed 1,150 lbs. and were rolled about the shop, the leather adhered perfectly and accomplished the desired results. Soon after this the Navy Department, after experimenting with the best glues on the market, adopted this, which was manufactured by Mr. Wachter as an employee, and for which he received no compensation other than his wages. During the recent war this glue was used in making ignition bags which form a part of all the fixed ammunition in the navy. Realizing the importance of the discovery, Mr. Wachter patented it and has placed it on the market. Its superiority lies not only in its great tenacity and in the wide range of substances with which it may be used, but in its strength under varying conditions of heat, cold, dampness and pressure, also it does not sour or spoil by standing, and it does away with the necessity of boiling and heating ill-smelling glue pots. There is a bright outlook for this liquid glue. Those who investigate it as a representative of this journal has done will find the investigation profitable. This is an animal glue in liquid form and is certainly a remarkable achievement. The Wachter Manufacturing Company, Baltimore, Md., will supply additional information.

NEW QUARTERS FOR THE BRODERICK & BASCOM ROPE COMPANY.

A careful study of the subject of wire rope and cable for many years has enabled them to put on the market a first-class article in their power steel and patent steel ropes. Among the many uses for this rope may be mentioned: guy ropes for derricks, wire tramways, endless wire ropeways for transportation of material over difficult roads, hoisting from deep shafts or inclined planes, transmission of power, switch ropes, etc., etc.

As an evidence of the "staying qualities" of this rope, the com-

pany calls attention to a letter recently received from the Greenview Coal & Mining Co., of Greenview, Ill., in which G. W. Hatch, secretary, says:

"Replying to your favor of December 31st, regarding the service of our 1-inch 19-wire power rope, purchased of you, is giving us. It has given us excellent satisfaction. On December 16th one of the sheaves and shaft broke and dropped a cage loaded with one car of coal, weighing at least 3,500 lbs., ten or twelve feet. The rope remained intact and saved the cage from going to the bottom if safety catches had failed to hold. We can cheerfully recommend your steel power rope."

In addition to wire rope, the company also handles manila rope of all sizes, and carry a full line of *tackle* and *snatch blocks* for manila and wire ropes, all sizes.

EQUIPMENT AND MANUFACTURING NOTES.

The 20-stall roundhouse of the Norfolk & Western Railway at Portsmouth, Ohio, has been equipped with a "hot blast" system of heating, the apparatus consisting of a large exhaust fan direct-connected to a horizontal engine and drawing air through a steam-coil heater built up of 1-in. steam piping on cast iron sections. From this apparatus air is distributed throughout the roundhouse by brick flues and galvanized iron piping, so arranged that heated air may be delivered into each engine pit. It will thus serve to melt off snow or ice from incoming locomotives when that is required. From the pits the heated air rises vertically, so that there is no trouble from smoke or steam in the inhabited zone of the building. On account of the dry character of the air supplied by the system, all moisture due to the melting of snow or ice is quickly evaporated, making it possible to work on an engine without discomfort within a very short time after it enters the building. During warm weather it is possible to operate the fan without steam in the heater, and in that manner provide a very thorough ventilation of the building, which is rarely accomplished in roundhouses equipped with the ordinary direct system of steam or hot-water heating. Other advantages, as compared with the direct system, are that there is no piping scattered about the building to freeze or burst in cold weather, there are no joints to leak, and there is no danger of fire from the proximity of steam pipes to inflammable materials. Since the piping is all concentrated in a steel-plated housing, where the velocity of the air passing over it is very high, much less length of pipe is needed than would otherwise be necessary. The above described equipment has been designed and installed by the B. F. Sturtevant Company, of Boston.

The Holland Company, with main offices in the Great Northern Building, Chicago, Ill., and who are well known through their Martin Metallic Flexible Joint and Holland Journal Box, announce the removal of their San Francisco office from 508 Market street to 12 Fremont street. The new location affords the excellent advantage of being on the ground floor as well as permitting basement storage, where they will carry a complete stock of the H. W. Johns-Manville Company's asbestos products, for which they are exclusive agents on the Pacific Coast, together with the Dake Engine Company's high speed engine and pneumatic chain hoists. Mr. J. C. Martin, Jr., vice-president of the company, will be manager of the San Francisco branch, with Mr. S. P. Russell, Jr., assistant manager.

The exhibit of the Corrington Air Brake Co. at the recent conventions marks their first introduction to our railroad friends. They show a triple with attachment for recharging auxiliary reservoirs while brakes are applied, and insuring a full reservoir when brakes are released. A high speed reducing valve and compact form of brake valve were included, the former very small, compact and capable of attachment to the brake cylinder without pipe connections, and the latter with feed valves for ordinary and high speed service. This company furnishes complete brake apparatus for railroad service and thoroughly interchangeable with the existing systems.

The North-Eastern Railway Company, of England, recently conducted a series of important brake trials on its lines, which at one point attain an elevation of 1,800 feet above sea level, and is one of the steepest sections of railway in the United Kingdom. Forty heavy coal cars comprised the train, each car being equipped with Westinghouse quick-acting brake. Despite high speed, unfavorable climatic conditions, and traveling on the down grade, the train was brought to a stand in a very short distance, the application of power on both front and rear wheels of the train being practically simultaneous. The trials are said to have been highly satisfactory.

The American Steam Gauge and Valve Manufacturing Company, Jamaica Plains, Boston, tendered the annual dinner to the sales department on the evening of July 1, at the Hotel Essex, Boston. This is in accordance with the wide-awake policy of the company, a part of which is to get all of the traveling men and branch house managers together with the home office, for an annual conference about the business and closing with a banquet. This is a pleasant and very important custom, indicating up-to-date business methods.

The value of graphite as a lubricant is well understood. The United States Graphite Company, Saginaw, Mich., confidently offer their "No. 205 Lubricating Graphite" for use of all who have to do with engines or machinery. It is pure and carefully prepared. Besides being used as a lubricant, it may be mixed with oil and used as a roof or stack paint or pipe-joint compound. A sample quarter pound will be furnished free for trial, and also complete instructions for use of graphite for lubrication. Further information may be had from the manufacturers.

Mr. William Burlingham has accepted an appointment as chief engine designer with the B. F. Sturtevant Company, of Hyde Park, Mass., resigning a position in the United States Inspection Office with the Wm. R. Trigg Company, of Richmond, Virginia. Mr. Burlingham has previously been associated with the Bath Iron Works, the General Electric Company, the Southwark Machine & Foundry Company, and the Newport News Shipbuilding & Dry Dock Company. He has also served on Mr. T. A. Edison's staff at the East Orange laboratory and is a graduate of the Worcester Polytechnic Institute.

The Consolidated "Axle Light" equipments of electric car lighting are coming into increasing use on the finest cars constituting some of the best and fastest trains of leading railway lines, including Pullman cars. All private Pullman cars and many business cars of railway officials, as well as private cars of individuals, are equipped with the Consolidated "Axle Light" system of electric lights. These "Axle Light" equipments are also beginning to be used quite extensively on the railway systems of Great Britain and Europe.

The Lunkenheimer Co., Cincinnati, Ohio, tendered the forty-first annual outing to 700 employees and their families July 18 at Woodsdale Island Park. The total number, including children, reached about 2,000. The entire expense of these pleasant outings is borne by the company.

The Allis-Chalmers Company has been awarded a contract for twenty-eight No. 8 Gates ball mills, thirty-nine 5 by 22-ft. Gates tube mills, and twenty-four rotary kilns of special design for the cement plants now building for the United States Steel Corporation at the Illinois Steel Company's plant at South Chicago.

Westinghouse-Parsons steam turbines will be used to drive the 50,000 kw. of electrical machinery for the new Rapid Transit subway and elevated system now under construction in Philadelphia. The machinery contract has just been closed by Westinghouse, Church, Kerr & Co.

Thomas Chalmers, father of W. J. Chalmers, chairman of the executive committee of the Allis-Chalmers Co., died July 13 and was buried Thursday, July 16. Thomas Chalmers was the founder of the firm of Fraser & Chalmers, which firm was recognized as the world's largest producer of mining machinery.

A. Leschen & Sons Rope Company, manufacturers of wire rope and aerial wire rope tramways, have moved their San Francisco office to the Rialto Building, corner of New Montgomery and Mission streets, San Francisco.

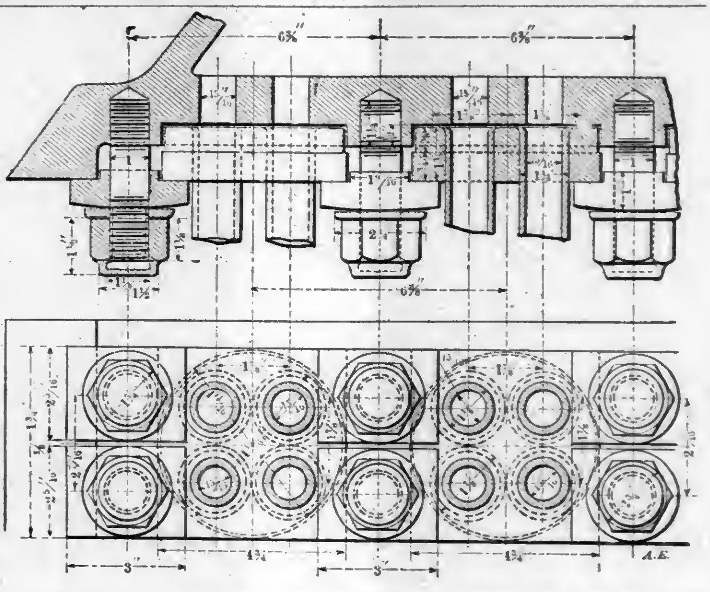
The Acme Supply Company, 100 Lake street, Chicago, has succeeded to the business heretofore conducted under the firm name of G. S. Wood & Co., consisting of Messrs. H. H. Schroyer, G. S. Wood and S. Woodworth.

Mr. D. G. Farragut has been appointed to represent the Pressed Steel Car Company in Mexico, with headquarters at Calle de Gante 8, City of Mexico, where all the business of this company in the Republic of Mexico will be managed.

The American Blower Company have taken contracts for heating apparatus for the new roundhouse of the Baltimore & Ohio at Keyser, W. Va., and for induced draft apparatus for the Chicago, Burlington & Quincy at Aurora, Ill.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL.

SEPTEMBER, 1903.



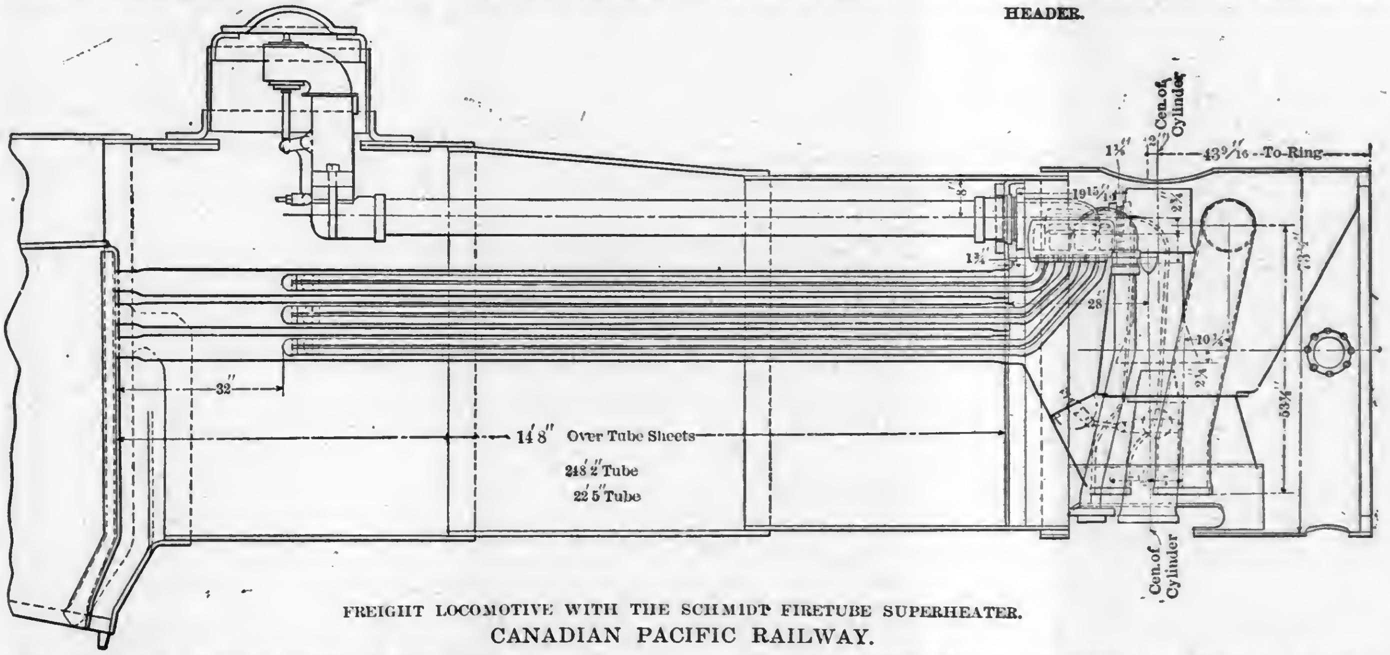
DETAILS OF THE ATTACHMENT OF THE SUPERHEATER TUBES TO THE HEADER.

COMPOUND LOCOMOTIVE WITH SUPERHEATER.

4—6—0 TYPE, FREIGHT.

CANADIAN PACIFIC RAILWAY.

In June, 1901, the Canadian Pacific Railway equipped a locomotive of the 4—6—0 type with the Schmidt system of superheating. It gave very gratifying results in fuel consumption and in operation. The locomotive was tested in comparison with a simple and a compound of similar construction and weight, the test continuing for eighteen months. On the ton-mile basis the superheater engine made an average saving in fuel of 31.3 per cent. over the simple engine and 10.6 per cent. over the compound, the cost of repairs being about the same for all three engines. These results led to the application of a Schmidt superheater to one of a lot of heavy 4—6—0 freight compounds, which are building at the Schenectady Works of the American Locomotive Company. Mr. E. A. Williams, superintendent of rolling stock of the Canadian Pacific, by whose permission this description is presented, believes that improvements in superheaters which will reduce the cost will render these devices highly desirable for locomotive service.

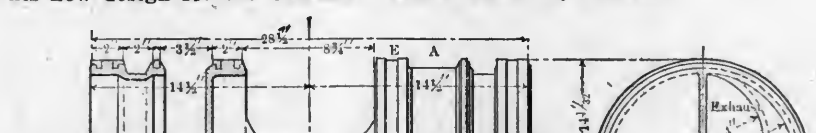


FREIGHT LOCOMOTIVE WITH THE SCHMIDT FIRETUBE SUPERHEATER.
CANADIAN PACIFIC RAILWAY.

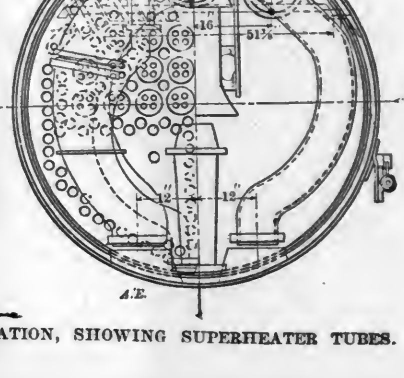
E. A. WILLIAMS, *Superintendent Rolling Stock.* AMERICAN LOCOMOTIVE CO., SCHENECTADY WORKS, *Builders.*

In our November, 1902, issue, page 340, Mr. Lentz described the Schmidt superheater as developed in Germany. This new design for the Canadian Pacific is entirely different in construction and is known as the smoke-tube superheater as distinguished from the smokebox form. The new construction seems much more likely to meet the idea of American railroad men than the smokebox type.

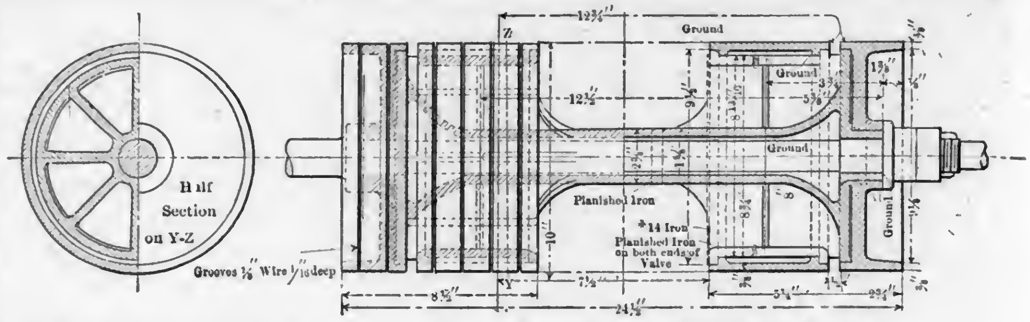
Instead of placing the superheater tubes in the smokebox they are taken from a header casting at the front end of the dry pipe and looped back through twenty-two 5-in. tubes toward the firebox. The superheater tubes, which are 1¼ ins. in diameter outside and 15-16 in. inside, reach within 32 ins. of the firebox ends of the large tubes but are not



DETAILS OF LOW-PRESSURE VALVE.



SMOKEBOX ELEVATION, SHOWING SUPERHEATER TUBES.



DETAILS OF HIGH-PRESSURE VALVE.

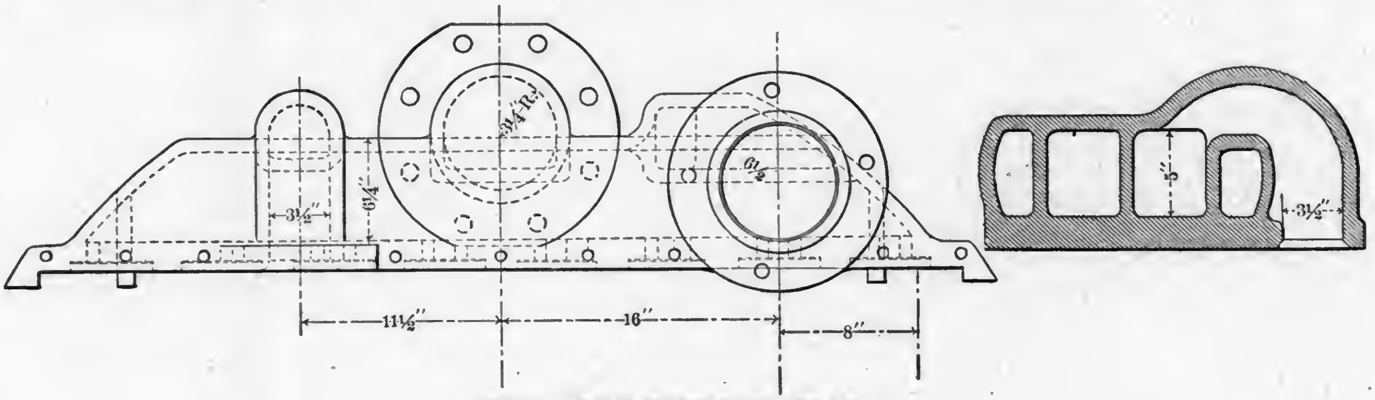
exposed to the direct heat of the firebox. Return bends at the ends of the superheater tubes take the superheated steam forward again to the header, which is partitioned off to separate the hot from the cooler steam. From here the branch pipes take the superheated steam to the cylinders. In the engravings this interesting arrangement is indicated. The large tubes are swaged down at the back ends and beaded in the usual manner. Each large tube contains two loops of the smaller tubes, which are braced by feet cast upon the return bends at the back ends. At the header casting the loops are removably connected so that they may be easily taken down for examination and repairs. The superheater pipes are solid drawn steel tubes, the amount of heating surface thus provided being 289.5 sq. ft.

A plate partition separates the main portion of the smoke box from the space containing the superheater header and the tube ends. A flat damper valve connects the spaces and this valve is opened by the steam pressure in the steam pipes acting through a small cylinder shown on the side of the smokebox. When the throttle is open this valve is also open and it closes by action of a counterweight when the throttle is closed. With this device the superheater tubes cannot become highly heated when steam is not passing through them and thus the greatest danger of burnt tubes is avoided. It will be noted that with this construction the smokebox is necessarily long to receive the superheater header, but that its diameter is not enlarged as was required with the earlier construction of smokebox superheater. The header takes the superheater tubes in groups of four. A detail drawing on page 317 shows the manner of securing the tubes to the heater so that they may be easily removed. The steam-tight joints are made against copper wire gaskets. The detail drawing below illustrates the construction of the header and the arrangement of the partitions. Other interesting details of this design will be presented in future numbers of this journal.

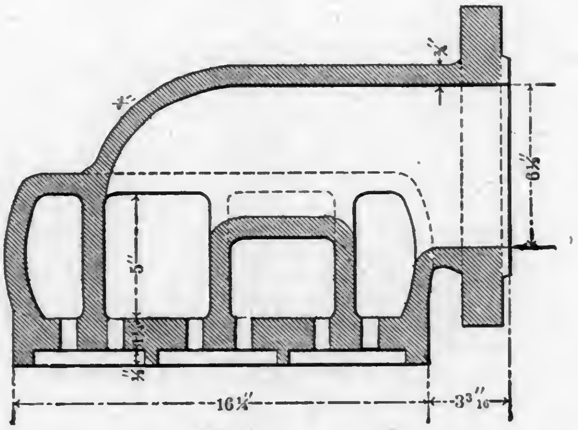
Both high and low-pressure valves are of the double ported piston type with internal admission. The low-pressure valve has L rings except the central ones on each side. The high-pressure valve is interesting in that it embodies unusual features to provide for the high temperature of the superheated steam. The packing rings are 5¼ and 2¾ ins. wide respectively, and are free to find their own bearings when the nuts are tight on the stem. They have no end movement, but adjust themselves laterally over the ground joints. The central cage has eight ⅜-in. ribs. The cage, ribs and central portion of the spindle of this valve are protected from the highly heated steam by planished iron shields, as indicated in the drawings. Cast iron is used in the construction of this valve. The drawing shows the locations of the packing grooves, which are ⅛ in. wide and 1-16 in. deep.

The small pipe leading from the T bend to the intercepting valve conveys saturated steam for starting the engine. The receiver and high-pressure steam pipe are arranged as usual.

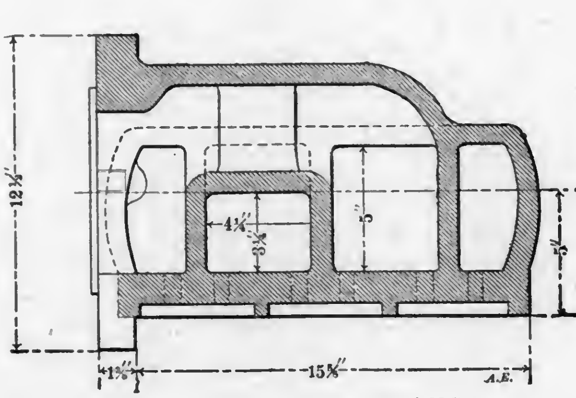
This locomotive will be put into service on a division adjacent to Montreal and will be run opposite to another of the same class, without the superheater. No special test other



DETAILS OF THE SUPERHEATER TEE HEAD.



VERTICAL SECTION OF ABOVE THROUGH CENTRAL FLANGE.



VERTICAL SECTION OF ABOVE THROUGH FLANGE AT RIGHT.

FREIGHT LOCOMOTIVE WITH SCHMIDT FIRETUBE SUPERHEATER.

CANADIAN PACIFIC RAILWAY.

than a comparison of service from month to month will be made. Mr. Williams believes that the improvements which have been made since the application of the first superheater on this road will tend to reduce the cost of construction and also of maintenance. It is stated that one of the 4-6-0 compounds now building for this road at Glasgow, Scotland, is also to be equipped with the Schmidt superheater.

Compound Locomotive with Superheater.
4—6—0 Type.—Freight.
Canadian Pacific Railway.
General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	187,500 lbs.
Weight on drivers	138,500 lbs.
Weight engine and tender in working order	310,200 lbs.
Wheel base, driving	14 ft. 10 ins.
Wheel base, rigid	14 ft. 10 ins.
Wheel base, total	26 ft.
Wheel base, total, engine and tender	54 ft. 6 ins.
Cylinders.	
Diameter of cylinders	22 and 35 ins.
Stroke of piston	30 ins.
Horizontal thickness of piston	L. p., 4⅛ ins.; h. p., 4¾ ins.
Diameter of piston rod	3¾ ins.
Kind of piston packing	Cast iron
Kind of piston-rod packing	Sullivan metallic
Valves.	
Kind of slide valves	Piston
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	H. p., 1¼ ins.; l. p., 1 in.
Inside clear of slide valves	H. p., ¼ in.; l. p., ⅜ in.
Lead of valves in full gear	L. p. 5-16-in. lead at 15-in. cut-off
Kind of valve-stem packing	Sullivan metallic
Wheels, Etc.	
Number of driving wheels	6
Diameter of driving wheels outside of tire	62 ins.
Material of driving wheel, centers	Cast steel
Thickness of tire	3 ins.
Tire held by	Shrinkage
Driving-box material	Cast steel
Diameter and length of driving journals	9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals,	Main side, 7½ x 4¾ ins., 7 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals,	5 ins. diameter x 4½ ins.
Section of rods	Main — I; side, I
Engine truck, kind	Four-wheel swing bolster
Engine truck, journals	6 ins. diameter x 10 ins.
Diameter of engine truck wheels	31 ins.
Boiler.	
Style	Extended wagon top
Style	Ex. wagon top
Outside diameter of first ring	70½ ins.
Working pressure	210 lbs.
Material of barrel and outside of firebox	Central steel
Thickness of plates in barrel and outside of firebox:	¾, 13-16, ½, 1 and 9-16 in.
Horizontal seams	Butt joint, sextuple riveted
Circumferential seams	Double riveted
Firebox, length	102⅛ ins.
Firebox, width	70⅝ ins.
Firebox, depth	Front, 74⅛ ins.; back, 59½ ins.
Firebox, material	Otis steel
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	4½ ins. front, 3½ ins. sides, 3½ ins. back
Firebox, crown staying	Radial, 1⅛ ins. diameter
Firebox, staybolts	Taylor iron, 1 in. diameter
Tubes, material and gauge:	Charcoal iron, No. 11, I. W. G.; Shelby steel, 3-16th
Tubes, number and diameter	248 2 ins. and 22 5 ins.
Tubes, length over tube sheets	14 ft. 8 ins.
Heating surface, tubes	2,311.25 sq. ft.
Heating surface, firebox	171.92 sq. ft.
Heating surface, total	2,483.17 sq. ft.
Grate surface	49.82 sq. ft.
Grate, style	Rocking
Ashpan, style	Railway company's style
Exhaust pipes	Single
Exhaust nozzles	5¼, 5½ and 5¾ ins. diameter
Smokestack, inside diameter	14½ ins.
Smokestack, top above rail	15 ft. 2 ins.
Boiler supplied by	Two Hancock injectors, No. 10
Tender.	
Style	Hopper
Weight, empty	52,700 lbs.
Wheels, number	8
Wheels, diameter	40 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	16 ft. 9½ ins.
Tender frame	10-in. steel channels
Tender trucks	Simplex bolsters
Water capacity	5,000 gals., Imperial
Coal capacity	10 tons

Extensive improvements are at present under way on the Buffalo division of the Delaware, Lackawanna & Western. A large number of culverts and small bridges are being replaced by heavy plate girder steel bridges, with concrete piers, of the most substantial construction. Two long trestles over ravines have been replaced by permanent earth fills by relocations of the right of way. Also a system of block signals is being installed by the Hall Company to protect a 35-mile section of the road across a valley west of Dansville, where a heavy pusher-engine service is required; this will greatly facilitate the movement of trains over this important section of the road.

DISTRIBUTED COST OF CAR REPAIRS.

WITH TABLE.

This exceedingly valuable table represents the results of a very carefully kept record of the cost of car repairs on an important trunk line and covers the complete year of 1902. It was kept for the purpose of ascertaining definitely the relative cost of maintaining various parts, with a view of revealing the weaknesses of present wooden car construction in order to show what parts needed the greatest amount of immediate attention. For example, it has been said that draft gear repairs amounted to from 50 to 75 per cent. of the total repairs to freight equipment. This record shows that these repairs amount to less than 25 per cent. and that the parts above the floor—chiefly roofs—cover 29 per cent. of the total.

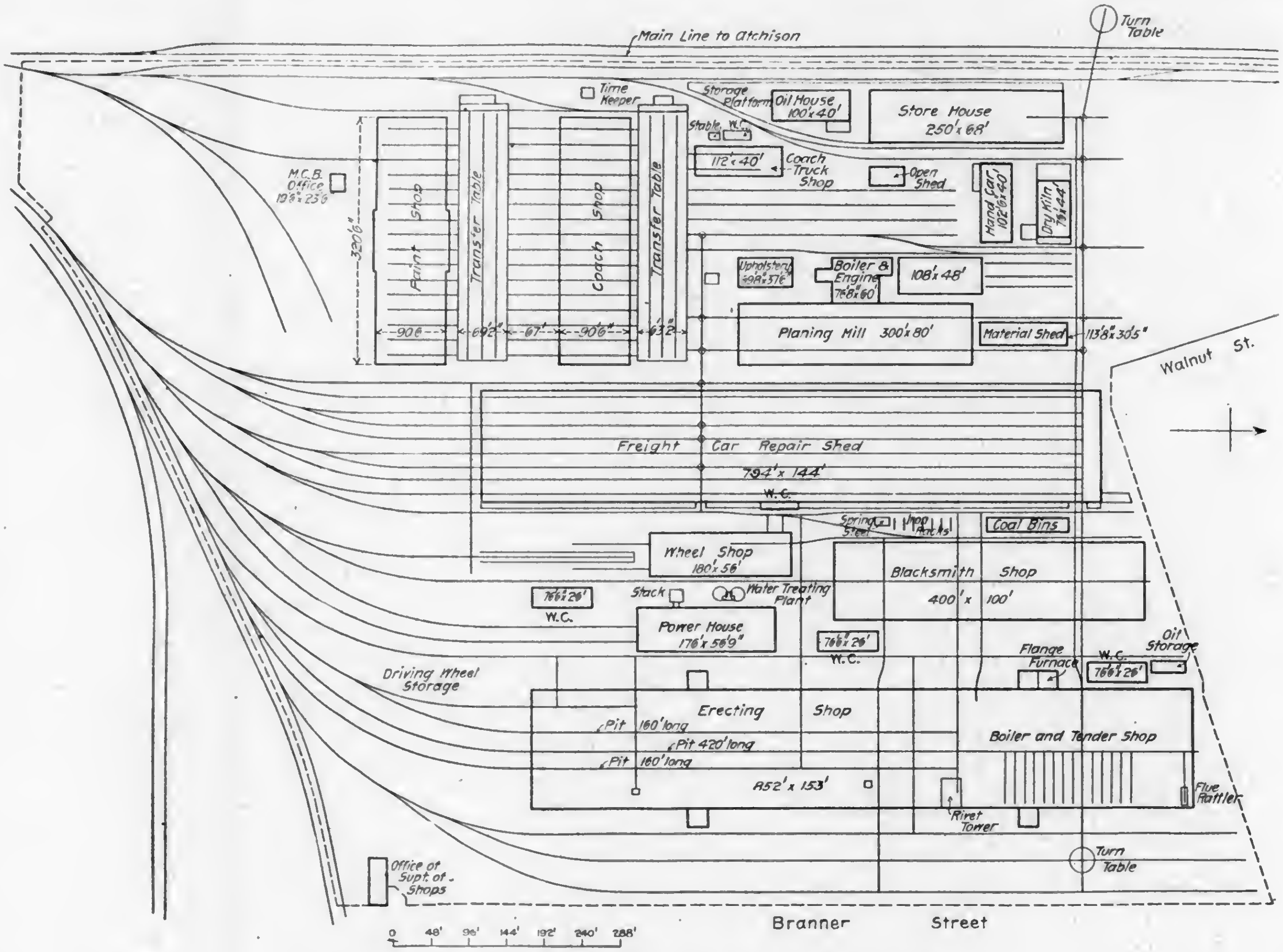
From this record we do not deem it safe to infer that because draft gear represents but 23 per cent. improvements in these parts are less important than those in roofs. The fact is that if friction draft gear is used the racking of roofs will be reduced, and the same is true in a measure of all other parts.

The total cost per car per year was $19.41. This and many other interesting facts are shown in the table.

COST OF CAR REPAIRS.

Average cost per car for repairs of freight cars, based on the year 1902.

Division.	A.		B.		C.		Foreign Cars.		Total.		
	Times repaired.	Cost per time repaired.	Times repaired.	Cost per time repaired.	Times repaired.	Cost per time repaired.	Times repaired.	Cost per time repaired.	Times repaired.	Cost per time repaired.	Percentage of total cost.
1—Couplers, complete	3,507	$1.76	6,431	$2.63	5,689	$2.63	9,995	$1.86	25,622	$2.21	12.68
2—Draft spring, followers, stops, pockets, spindles, etc.	3,657	1.05	3,190	1.07	7,887	1.19	6,893	1.10	21,627	1.12	5.44
3—Draft timbers, draft arms and bolts for same	1,922	2.43	2,688	1.47	5,942	.90	4,812	1.07	15,364	1.25	4.29
4—Uncoupling levers, brackets and chains	1,848	.27	1,424	.28	3,036	.27	1,135	.20	7,446	.27	.44
5—Body bolsters:											
(a) Metal	3	1.88	9	5.00	23	2.91	....	....	35	3.23	.03
(b) Wooden	4	4.76	5	4.36	15	2.27	3	3.81	27	3.19	.02
6—Sills:											
(a) Center	154	9.74	270	10.46	574	9.11	2	12.27	1,000	9.58	2.15
(b) All other longitudinal sills	336	7.97	458	9.37	994	11.63	2	10.28	1,7[illegible]5	10.56	4.15
(c) End sills	312	4.20	674	2.90	1,141	2.63	29	2.99	2,1[illegible]6	2.94	1.00
7—Trucks:											
(a) Wearing parts, wheels, axles, bearings, etc.	1,571	7.47	3,608	4.53	2,875	4.33	11,482	4.54	19,536	4.74	20.78
(b-1) Metal bolsters	22	45.08	1	39.00	35	31.71	4	4.78	62	34.63	.48
(b-2) Wooden bolsters	297	4.26	651	4.09	1,259	3.32	395	4.14	2,602	3.75	2.18
(c) Fixed parts	6,394	.91	3,031	.94	8,960	.99	7,269	.75	25,654	.90	5.15
8—Brakes:											
(a) Foundation	9,569	.41	8,496	.66	10,320	.74	14,567	.53	42,952	.58	5.61
(b) Air	4,189	.67	5,238	.98	8,624	1.24	8,230	.80	26,281	.96	5.66
9—All other parts of car above floor	15,665	2.24	10,986	3.13	14,799	1.26	13,866	.80	60,316	2.16	29.52
Entire car	37,944	2.16	34,276	2.91	31,791	4.52	71,806	1.68	175,817	2.52	100.00
Cost per car per year, based on above											$19.41



GROUND PLAN OF THE NEW SANTA FE LOCOMOTIVE SHOPS AT TOPEKA.

INTERIOR OF LOCOMOTIVE ERECTING SHOP, LOOKING NORTH.

NEW LOCOMOTIVE SHOPS AT TOPEKA, KAN. —ATCHISON, TOPEKA & SANTA FE RAILWAY.

NEW LOCOMOTIVE SHOPS AT TOPEKA.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

I.

GENERAL PLAN AND LOCOMOTIVE-SHOP BUILDING.

The old shops of this road at Topeka and a proposed plan for extensions were illustrated and the arrangement of the buildings discussed in this journal in June, 1901. Increased facilities have been secured by building a new locomotive shop, including in one fine building the erecting, machine and boiler shops. In addition to this, a new blacksmith shop, power-house and accessories have been put up, the new plant having been put into service in March last. A capacity to repair 50 locomotives per month was planned. There are but two larger locomotive-repair shops in the country—those at Altoona and Reading; and one equal to it in size—at Roanoke, Va. In May forty locomotives were in the shop, 24 on the so-called "pits" and 16 for new fireboxes. In the month of April 30 engines were turned out, the plant having been put into service March 15.

This plant is the largest on the road, and its equipment is to provide for all fireboxes east of Raton, N. M., and north of Texas; also for general repair work to about 350 engines, besides helping out all of the other shops on the road for the heaviest work. Twenty-one days are allowed for new fireboxes and the general repairs usually accompanying such work, and 10 days for light repairs. About 130 fireboxes will be put in this year. Fast and ample crane service characterizes this shop. The easiest thing about the plant is to move material, heavy or light. About 1,650 men are employed in both locomotive and car departments and about 1,200 in the locomotive works alone. Considerable manufacturing is done here; for example, all axles for the entire system are made at Topeka, and this principle is being carried out in other departments of the shop by aid of a lot of up-to-date machinery.

The locomotive shop is selected for the first installment of this description. Special attention will later be given to the power-house, blacksmith shop, and the equipment of all the departments.

The erecting, machine and boiler shops are combined in a magnificent building 850 ft. long by 155 ft. wide. Continuous crane service extends the full length of the machine shop and through the erecting and boiler shops, which use the same cranes. A cross section of the building is given, and a complete ground plan will appear with the presentation of the equipment, showing tool locations. The section shows the height of the crane girders and the spans.

This is a "longitudinal" shop, and the arrangement permits of the utmost elasticity in the use of the floor space. There are three tracks at 23-ft. centers in the central or erecting-shop bay, which is 74 ft. wide. The central track has a pit extending 420 ft. from the south end, and the other tracks have 160-ft. pits. The rest of the floor is available for engines and has longitudinal tracks, but no pits. The engines are "staggered" in order to get room to take out flues and yet stand them close together. This plan seems to work out very well. The operation of the plant will be given in detail later.

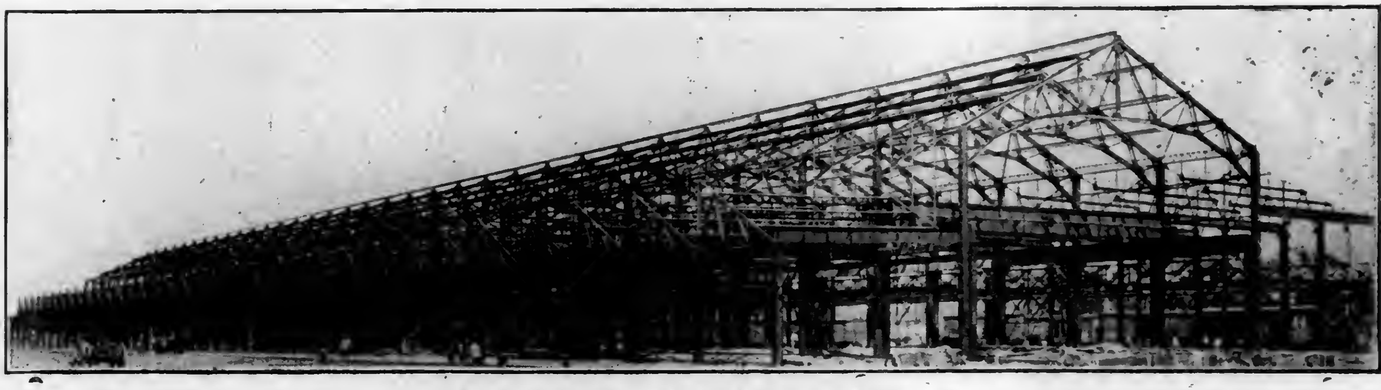
The west bay is for heavy machinery, that on the east side for lighter machinery and tenders, and overhead at the south end is a gallery 525 ft. long for brass, tool and air-brake rooms and the tin shop. Near the center of the east bay is the riveting tower, which is 62 ft. high, to the crane rails. Both side bays have the weaving shed type of roof, the construction of which is clearly seen in the engravings. In the construction the steelwork was completed by itself. The engravings show the large amount of natural lighting and the portions of the walls which are built of brick. These are 13 ins. thick. The roofs are of Ludowici tile, and the skylights are of translucent fabric, 12 ft. wide. These extend on each side of the roof the full length of the building, and along the ridge Star ventilators are spaced at 50-ft. centers.

The crane and building columns are spaced at 25-ft. centers and supported on large concrete foundations. For the roof calculations the assumed loads were:

Snow	10 lbs. per ft.
Wind	25 lbs. per ft.
Covering	15 lbs. per ft.
Total	50 lbs. per ft.

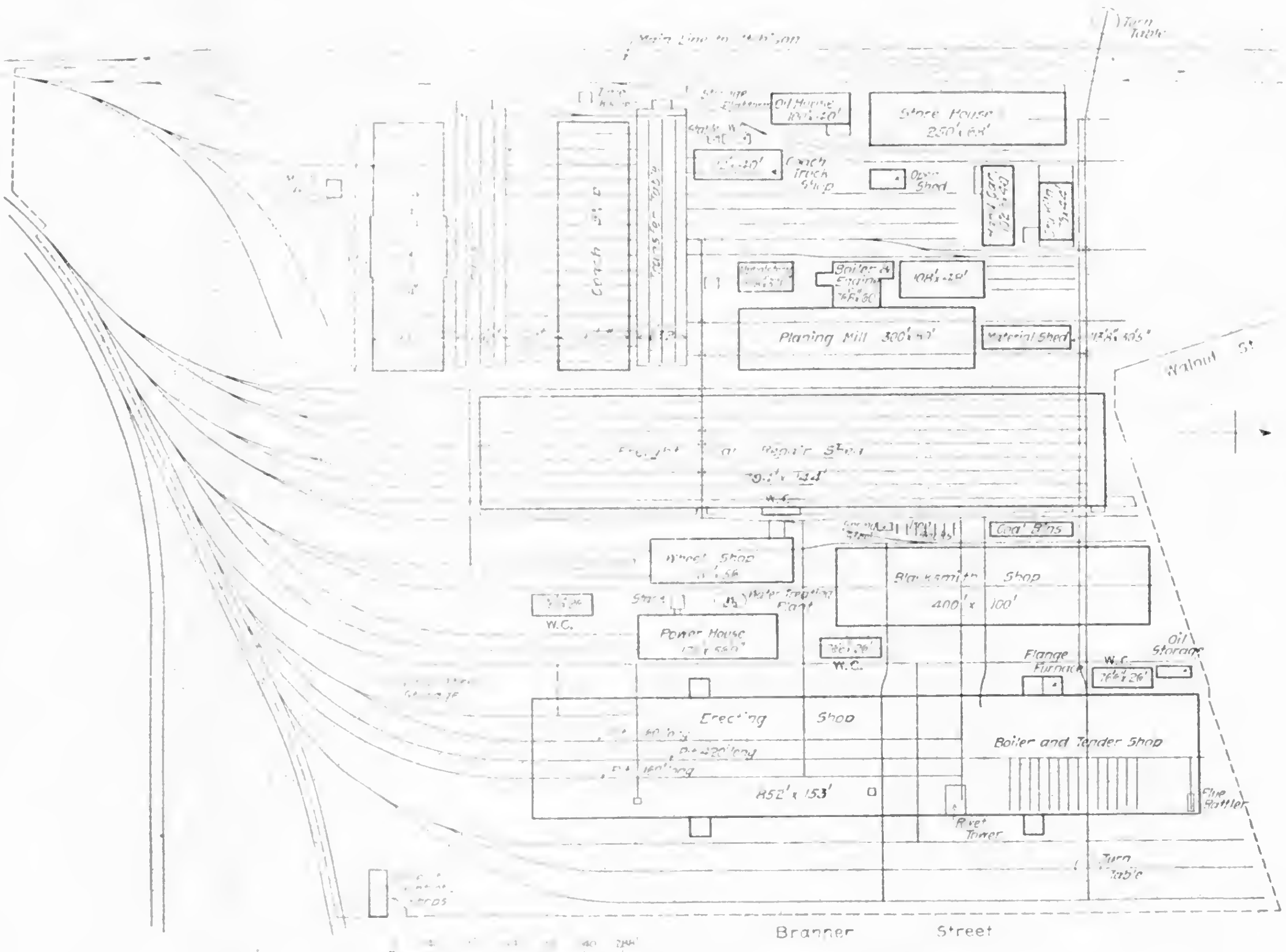
The tension members were confined to 16,000 lbs. per square inch and the compression members to 14,000 lbs. The building

VIEW OF MAIN LOCOMOTIVE SHOP, FROM THE SOUTHEAST.



THE STEEL SKELETON OF THE LOCOMOTIVE SHOP.

NEW LOCOMOTIVE SHOPS AT TOPEKA, KAN.—ATCHISON, TOPEKA & SANTA FE RAILWAY.



GROUND PLAN OF THE NEW SANTA FE LOCOMOTIVE SHOPS AT TOPEKA.

INTERIOR OF LOCOMOTIVE ERECTING SHOP, LOOKING NORTH.

NEW LOCOMOTIVE SHOPS AT TOPEKA, KAN. —ATCHISON, TOPEKA & SANTA FE RAILWAY.

NEW LOCOMOTIVE SHOPS AT TOPEKA.

Atchison, Topeka & Santa Fe Railway.

I.

GENERAL PLAN AND LOCOMOTIVE-SHOP BUILDING.

The old shops of this road at Topeka and a proposed plan for extensions were illustrated and the arrangement of the buildings discussed in this journal in June, 1901. Increased facilities have been secured by building a new locomotive shop, including in one fine building the erecting, machine and boiler shops. In addition to this, a new blacksmith shop, power-house and accessories have been put up, the new plant having been put into service in March last. A capacity to repair 59 locomotives per month was planned. There are but two larger locomotive-repair shops in the country—those at Altoona and Reading; and one equal to it in size—at Roanoke, Va. In May forty locomotives were in the shop, 24 on the so-called "pits" and 16 for new fireboxes. In the month of April 30 engines were turned out, the plant having been put into service March 15.

This plant is the largest on the road, and its equipment is to provide for all fireboxes east of Raton, N. M., and north of Texas; also for general repair work to about 350 engines, besides helping out all of the other shops on the road for the heaviest work. Twenty-one days are allowed for new fireboxes and the general repairs usually accompanying such work, and 10 days for light repairs. About 130 fireboxes will be put in this year. Fast and ample crane service characterizes this shop. The easiest thing about the plant is to move material, heavy or light. About 1,650 men are employed in both locomotive and car departments and about 1,200 in the locomotive works alone. Considerable manufacturing is done here; for example, all axles for the entire system are made at Topeka, and this principle is being carried out in other departments of the shop by aid of a lot of up-to-date machinery.

The locomotive shop is selected for the first installment of this description. Special attention will later be given to the power-house, blacksmith shop, and the equipment of all the departments.

The erecting, machine and boiler shops are combined in a magnificent building 850 ft. long by 155 ft. wide. Continuous crane service extends the full length of the machine shop and through the erecting and boiler shops, which use the same cranes. A cross section of the building is given, and a complete ground plan will appear with the presentation of the equipment, showing tool locations. The section shows the height of the crane girders and the spans.

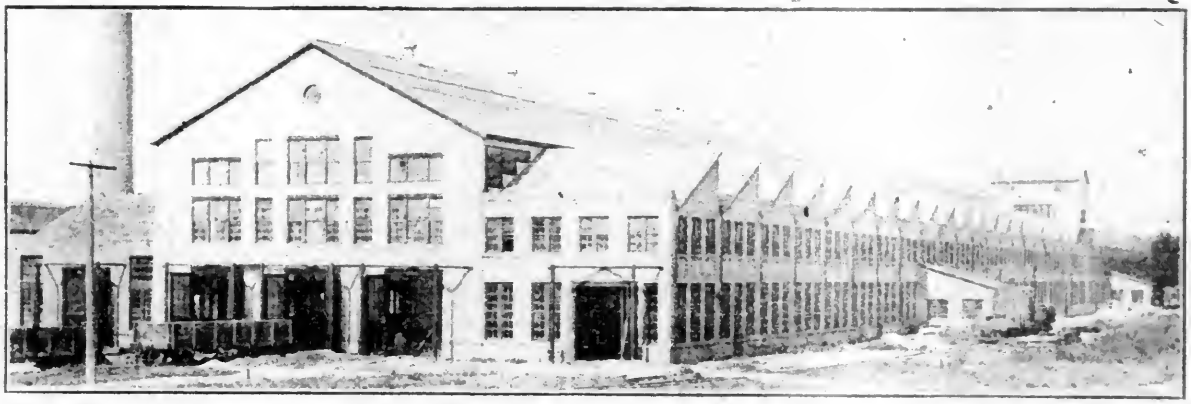
This is a "longitudinal" shop, and the arrangement permits of the utmost elasticity in the use of the floor space. There are three tracks at 23-ft. centers in the central or erecting-shop bay, which is 71 ft. wide. The central track has a pit extending 420 ft. from the south end, and the other tracks have 160-ft. pits. The rest of the floor is available for engines and has longitudinal tracks, but no pits. The engines are "staggered" in order to get room to take out flues and yet stand them close together. This plan seems to work out very well. The operation of the plant will be given in detail later.

The west bay is for heavy machinery, that on the east side for lighter machinery and tenders, and overhead at the south end is a gallery 525 ft. long for brass, tool and air-brake rooms and the tin shop. Near the center of the east bay is the riveting tower, which is 62 ft. high, to the crane rails. Both side bays have the weaving shed type of roof, the construction of which is clearly seen in the engravings. In the construction the steelwork was completed by itself. The engravings show the large amount of natural lighting and the portions of the walls which are built of brick. These are 13 ins. thick. The roofs are of Ludowici tile, and the skylights are of translucent fabric, 12 ft. wide. These extend on each side of the roof the full length of the building, and along the ridge Star ventilators are spaced at 50-ft. centers.

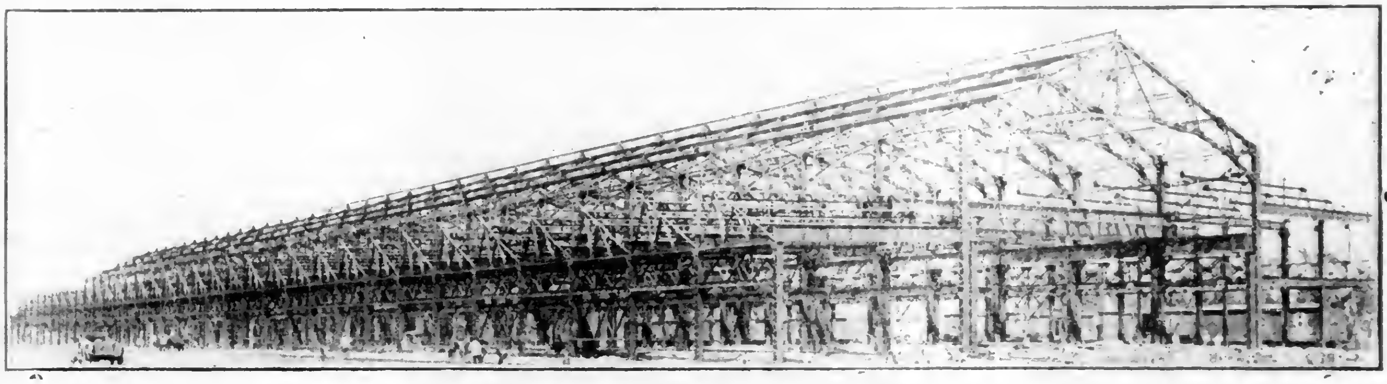
The crane and building columns are spaced at 25-ft. centers and supported on large concrete foundations. For the roof calculations the assumed loads were:

Snow	10 lbs. per ft.
Wind	25 lbs. per ft.
Covering	15 lbs. per ft.
Total	50 lbs. per ft.

The tension members were confined to 16,000 lbs. per square inch and the compression members to 14,000 lbs. The building

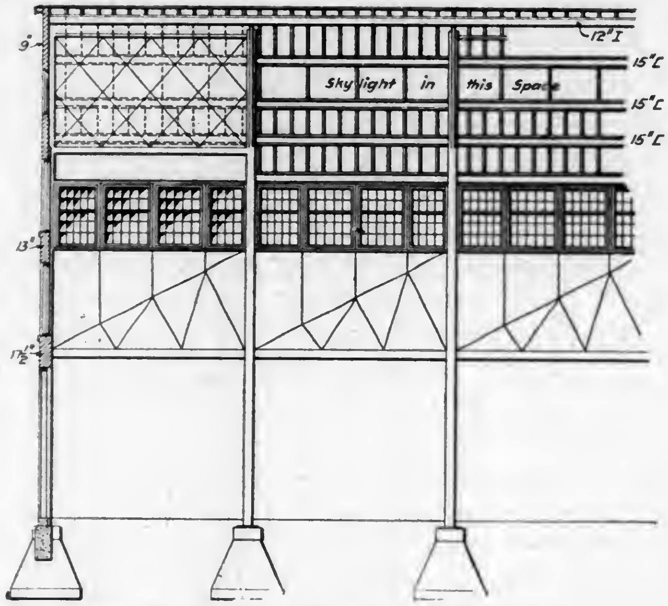


VIEW OF MAIN LOCOMOTIVE SHOP, FROM THE SOUTHEAST.

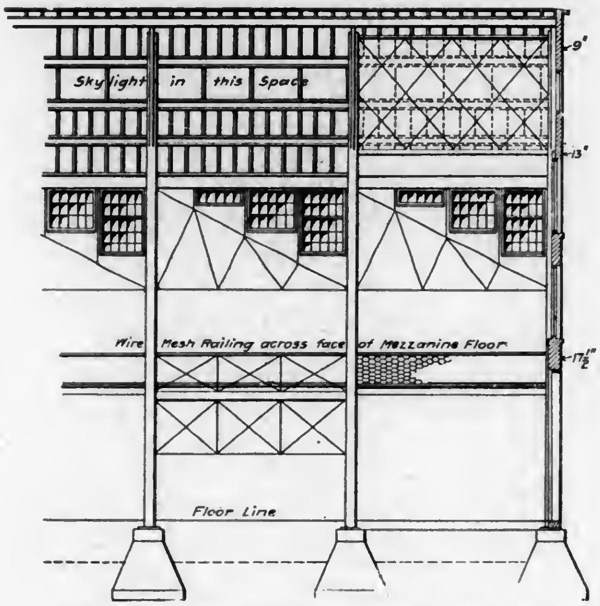


THE STEEL SKELETON OF THE LOCOMOTIVE SHOP.

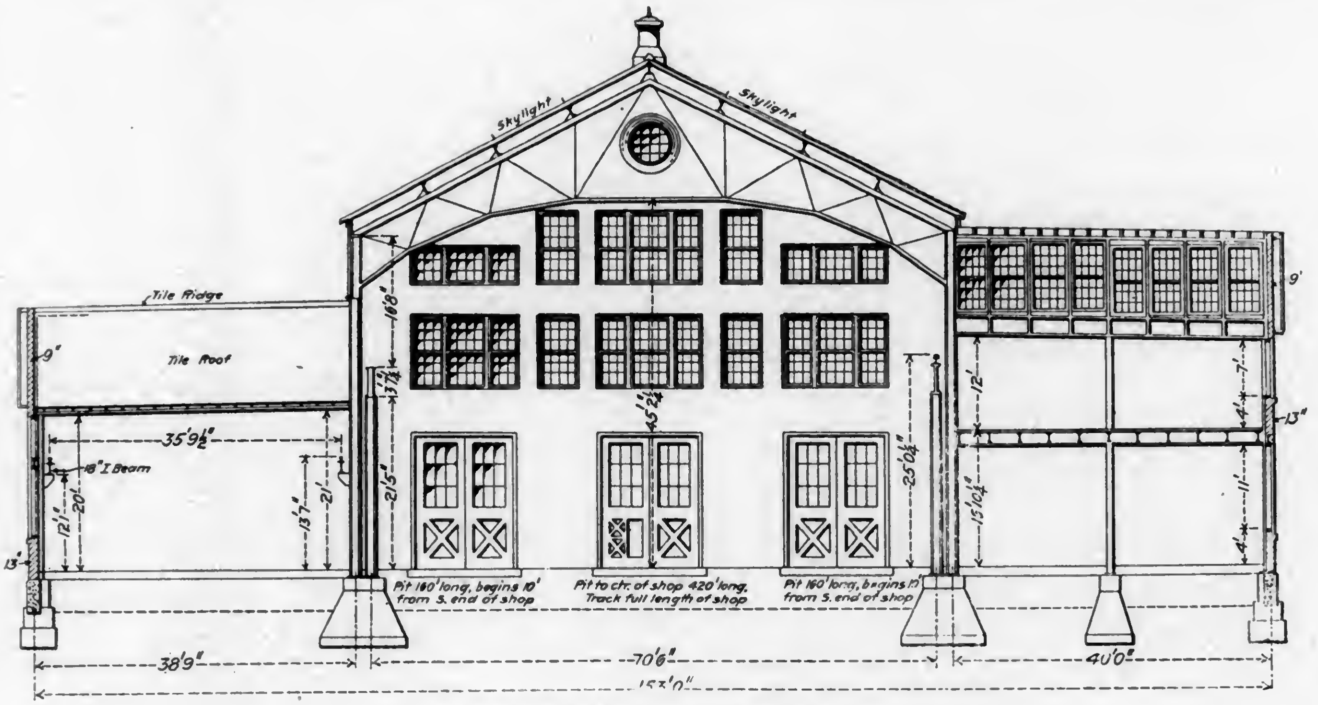
NEW LOCOMOTIVE SHOPS AT TOPEKA, KAN.—ATCHISON, TOPEKA & SANTA FE RAILWAY.



STEEL FRAME OF LOCOMOTIVE SHOP, WEST SIDE.



STEEL FRAME OF LOCOMOTIVE SHOP, EAST SIDE.



CROSS SECTION OF LOCOMOTIVE SHOP BUILDING.

NEW LOCOMOTIVE SHOPS AT TOPEKA, KAN.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

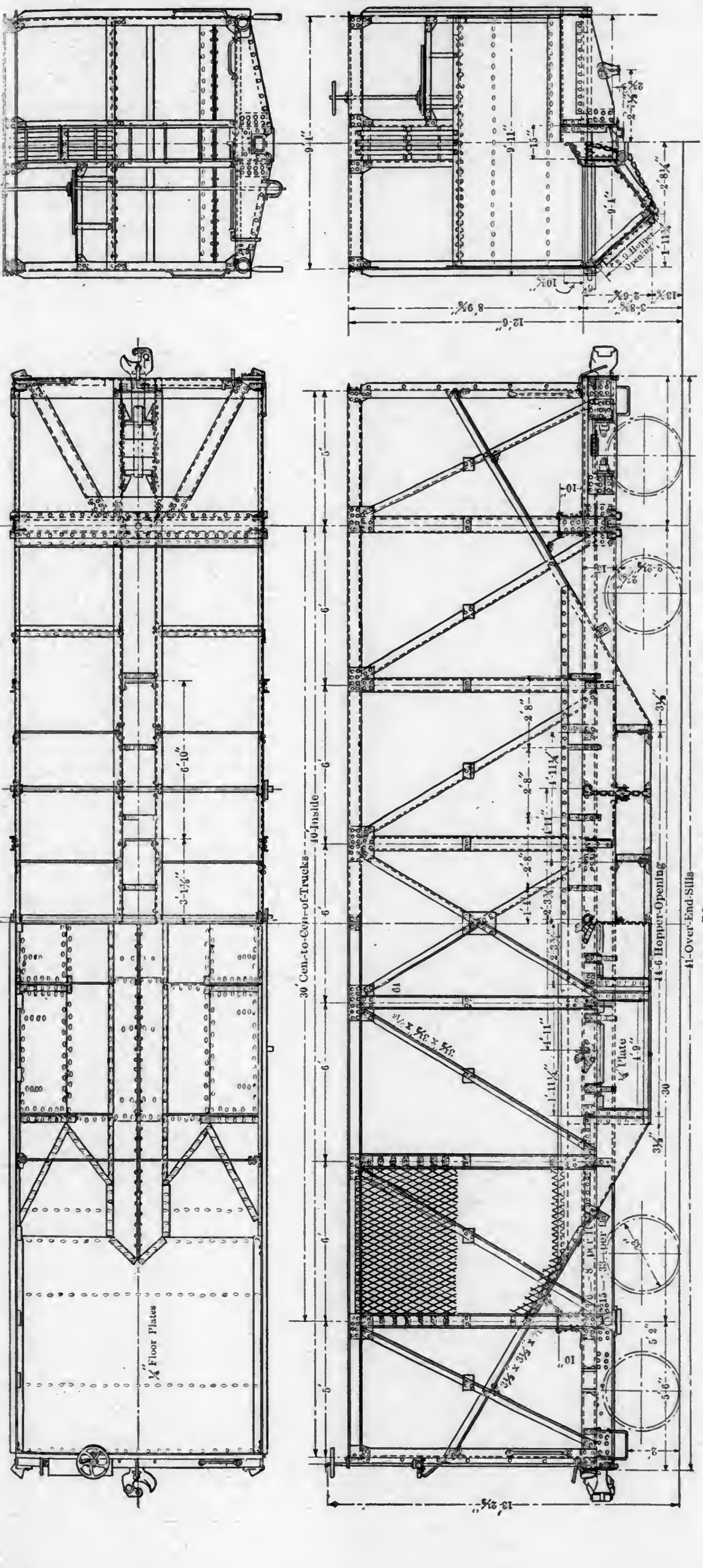
columns are built of 15-in. I-beams, in pairs, the main crane girders being supported on similar columns.

The floor is of concrete 6 ins. thick laid on the ground. On this are 2 x 4-in. timbers of yellow pine placed 18 ins. apart and covered with 2-in. tongued and grooved maple. The shop tracks are laid on pine ties treated with the zinc chloride process at the tie-treating plant of the company in New Mexico. The pits are of concrete, and the rails are placed on stringers. Where ties are used the concrete floor finishes up to the ends of the ties, which may be removed without disturbing the permanent floor.

These extensive improvements have been in preparation for several years. The buildings were designed and constructed under the direction of Mr. W. B. Storey, chief engineer, and Mr. A. F. Robinson, bridge engineer. The equipment of the shops and its arrangement were under the direction of Mr. G. R. Henderson, whose administration as superintendent of motive power began after the preliminaries and the buildings were provided. Mr. F. H. Adams, engineer of shop extension, was in charge of the machinery and installation, and the unusual state of efficiency of the new plant, which was practically in full working order in 30 days after it was put into service, is largely due to the careful preliminary plans for the reception of the machinery. Mr. John Purcell is superintendent of the entire plant at Topeka. Shops of this size need the individual attention of a specialist in shop administration, and other roads would do well to follow this example by removing such responsibilities from officers who have their attention fully occupied with the operation of locomotives on the road.

The power-house, electrical distribution, machinery, and operation of these interesting shops will be subjects of subsequent articles.

Company. The heating system was furnished by the B. F. Sturtevant Company, and the complete electrical equipment, for both lighting and power distribution, was furnished by the General Electric Company.



VANDERBILT 50-TON COKE CAR.—LACKAWANNA COAL AND COKE CO.

SOUTH BALTIMORE STEEL CAR AND FOUNDRY CO., *Builders.*

CORNELIUS VANDERBILT, *Designer.*

VANDERBILT 50-TON COKE CAR.

LACKAWANNA COAL & COKE COMPANY.

Coke cars are now being built to the design and under the patents of Mr. Cornelius Vanderbilt, by the South Baltimore Steel Car & Foundry Company, for the use of the Lackawanna Coal & Coke Company. The accompanying engraving illustrates the construction.

Length over end sills	41 ft. 0 in.
Length inside	40 ft. 0 in.
Width inside	9 ft. 4 ins.
Width outside of body	9 ft. 11 ins.
Height top of side to top of rail	12 ft. 6 ins.
Weight, light, estimated	37,000 lbs.
Capacity, 30 degs. heap	3,744 cu. ft.
Capacity, level	3,295 cu. ft.
Capacity, coke, 30 degs. heap	114,344 lbs.
Capacity, coke, level full	100,497 lbs.
Weight of coke, averages (cu. ft.)	38.5 lbs.

The sides are in the form of trussed girders, with diagonal braces of angles. The side sills are 6-in. 8-lb. channels and the center sills 15-in. 33-lb. channels. Six-inch 10½-lb. channels form the top chords, while the side sills form the bottom chords. The body bolsters are similar to those used in the Vanderbilt hopper coal cars for the West Virginia Central & Pittsburg Railway (AMERICAN ENGINEER, April, 1902, page 103). The bolsters are built up of two 10-in. 15-lb. channels, forming box girders resting on top of the center and side sills. Depending plates are secured to the webs of the center and side sills and the side bearings are secured to these plates. Floor plates ¼ in. thick are used throughout. Form, ⅜-in. frame diaphragm plates connect the side and center sills on each side.

Expanded metal is used for the sides and a saving of 25 per cent. in weight secured. This material was furnished by the New York Expanded Metal Company and has 3-in. meshes, the material being twisted and disposed in such a way as to supply lateral stiffness sufficient for this material. There is no stress upon the expanded metal except the side thrust of the coke. Riveted clips hold the expanded metal to the frame so that it cannot become loose. These are secured over turned-up edges of the metal.

The hoppers are arranged to dump at the sides of the car and a pair of doors may be operated simultaneously, to distribute the load, when desired. The load is dumped outside of the track. Three winding shafts operate the doors as indicated in the engraving. The slope of the main hopper floor is 30 deg. These cars are equipped with the Sessions-Standard Friction Draft Gear. The details of this design were developed by Mr. L. A. Shepard under the direction of Mr. Vanderbilt.

A NEW IDEA IN ELECTRIC LOCOMOTIVE DESIGN.

THE MULTIPLE-UNIT SYSTEM APPLIED TO HEAVY ELECTRIC TRACTION.

BALTIMORE & OHIO RAILROAD.

The General Electric Company has just turned out from its Schenectady Works an electric locomotive for the Baltimore & Ohio which is, in its entirety, the heaviest and most powerful locomotive ever built up to this time, whether steam or electrically propelled. It is intended for use in the peculiar class of service met in the Belt Line Tunnel of the Baltimore & Ohio at Baltimore, Md., where a third-rail system of electric traction has been in successful use for several years, as most of our readers well know.

The section of the Belt Line over which this locomotive will be operated extends from the Camden Street Station through the tunnel to the summit of the grade outside the tunnel, a distance of 3½ miles. It will handle all the freight traffice of the Baltimore & Ohio passing through Baltimore, in the same manner as the present electric locomotives, built by the General Electric Company, which have been in successful operation for the past eight years.

The specifications called for an electric locomotive capable of handling a 1,500-ton train, including the steam locomotive, but excluding the electric locomotive, on a maximum grade of 1½ per cent., at 10 miles per hour, with corresponding higher speed on lighter grades. This required a locomotive weighing approximately 160 tons on the drivers for purposes of adhesion, so that the engineers of the General Electric Company decided that the most practicable scheme was to build an articulated locomotive consisting of two complete 80-ton units operated together as one locomotive by means of the Sprague-General Electric multiple-unit system of control. The result has been the locomotive illustrated in the engraving, and it promises from the first trials to more than meet the expectations of the designers.

The entire locomotive consists of eight G.E.-65 motors, four in each half-section. These motors have each a capacity of 225 h.p., making the total capacity of the locomotive 1,800 h.p. Each section is equipped with the multiple-unit system of control and is so arranged as to permit it to be operated independent of the other, or to operate as well when several sections are coupled together. The controlling apparatus for each section consists of master controllers, engineer's valves, etc., in duplicate, a complete set being located in diagonally opposite corners of each cab, so that the engineer can stand in the front end of the locomotive when running in either direction.

The cab is large and roomy. The floor rests on the truck frame, the lining floor being of 1¾-in. hard pine, tongued and grooved, and the upper floor of hard pine, ⅞ in. thick, tongued and grooved and laid in the opposite direction. The sides and roof of the cab are of sheet steel. There is an entrance door on each side, and at each end there is an additional door which permits of ready communication between sections when coupled together. Large windows afford an unobstructed view in all directions.

Each section of the locomotive is equipped with a bell, a whistle, two locomotive headlights, Leach pneumatic track sanders and a complete air-brake equipment, including two engineer's valves and air gauges.

The main body of the truck frame consists of a rectangular framework of cast steel, built up strong and heavy, of four pieces, two side frames and two end frames. The parts are securely fitted by machining at the ends and bolted together, thus forming a very strong and rigid structure capable of withstanding the most severe shocks. The end pieces are very massive and form the buffer beams, and to which a standard draft gear is attached. The side frames have machined jaws protected by wearing shoes, between which the journal boxes slide.

The truck frames are supported at four points on equalizers. Each equalizer rests on a pair of half-elliptic springs, the ends of which are supported on top of the journal boxes through wearing plates. The journal boxes are made similar to standard car journal boxes, the parts, however, being larger and stronger. The brasses can be easily removed, and by dropping down the wearing shoes it is possible to remove a journal box complete without removing the wheels and axles or other parts of the truck.

In order that the locomotive may round curves easily, the axles are given considerable lateral movement in the journal boxes, it being practical to do this with the electric locomotive design and thus reduce the effective rigid wheel base. The wheels, axles or motors can be easily removed from the trucks by dropping into a suitably constructed pit or by raising the truck frame.

Each section of the locomotive has eight steel-tired spoked wheels. The tires are 2⅞ ins. thick, with M. C. B. standard tread and flange, and are securely held in place by approved fastenings. The axles are made of forged steel, turned throughout, 6 x 12 ins. in the truck journal-bearings, 8 ins. in the wheel fit and 7½ ins. in the motor bearings.

THE NEW MULTIPLE-UNIT ELECTRIC LOCOMOTIVE.—THE HEAVIEST AND MOST POWERFUL LOCOMOTIVE EVER BUILT.
BALTIMORE & OHIO RAILROAD. GENERAL ELECTRIC CO., *Builders*.

THE PROPER HANDLING OF THE TONNAGE RATING SYSTEM.

By R. S. Wickersham,

ASSISTANT ENGINEER OF TESTS, SANTA FE COAST LINES.

The question of tonnage and tonnage rating is one which has come rapidly into prominence in the last three or four years, and although much has been written on this subject in the technical papers and has formed the topic of discussion at many railway club meetings, still, on most railroads, it is far from being worked on a satisfactory basis at the present time. One of the principal troubles has been that, when the cry went up all over the country for a system of engine rating by the tonnage method, too many officials went into it without any knowledge of the subject and, in their zeal, made the tonnage heavier than has been found wise for the most economical results, both in engine and train service. Recently, however, a reaction has set in and the mistakes made in inaugurating the system are being slowly rectified.

One of the most important rectifications that is slowly being made in a great many parts of the country is that of abolishing the double-header system, the economy of which, the writer believes, has never been fully demonstrated.

It is a fact generally admitted that whenever a division yard gets "blocked" the superintendent runs singlehead trains and in a short time has the yard clear once more. Again, with the heavy power that is being built at the present time, the tractive force that is developed by two engines is enormous, and the numerous light capacity cars still in existence are unable to stand the strain, especially if near the head end of the train. The writer knows of cases where there were as many as twelve break-in-twos in a doublehead freight train in running over one division, each engine on this train developing 40,000 lbs. tractive force. In such cases the overtime would more than offset the saving in train crews' wages, to say nothing of the damage to equipment.

In a great many instances the rating of engines has been assigned to the operating department instead of putting it where it naturally belongs, viz., with the superintendent of motive power, who, if anyone, knows how hard an engine should be worked to obtain the most economical results and serve the best interests of the railroad company. One of the chief objections for leaving the rating of engines in the hands of the operating department, or, to put it where it generally goes, to the division superintendents, is that in their anxiety to make a good showing they lose sight of the importance of giving the engines a fair rating, which they can handle, and load the engines to such an extent that the overtime and engine failures more than compensate for the increased tonnage hauled.

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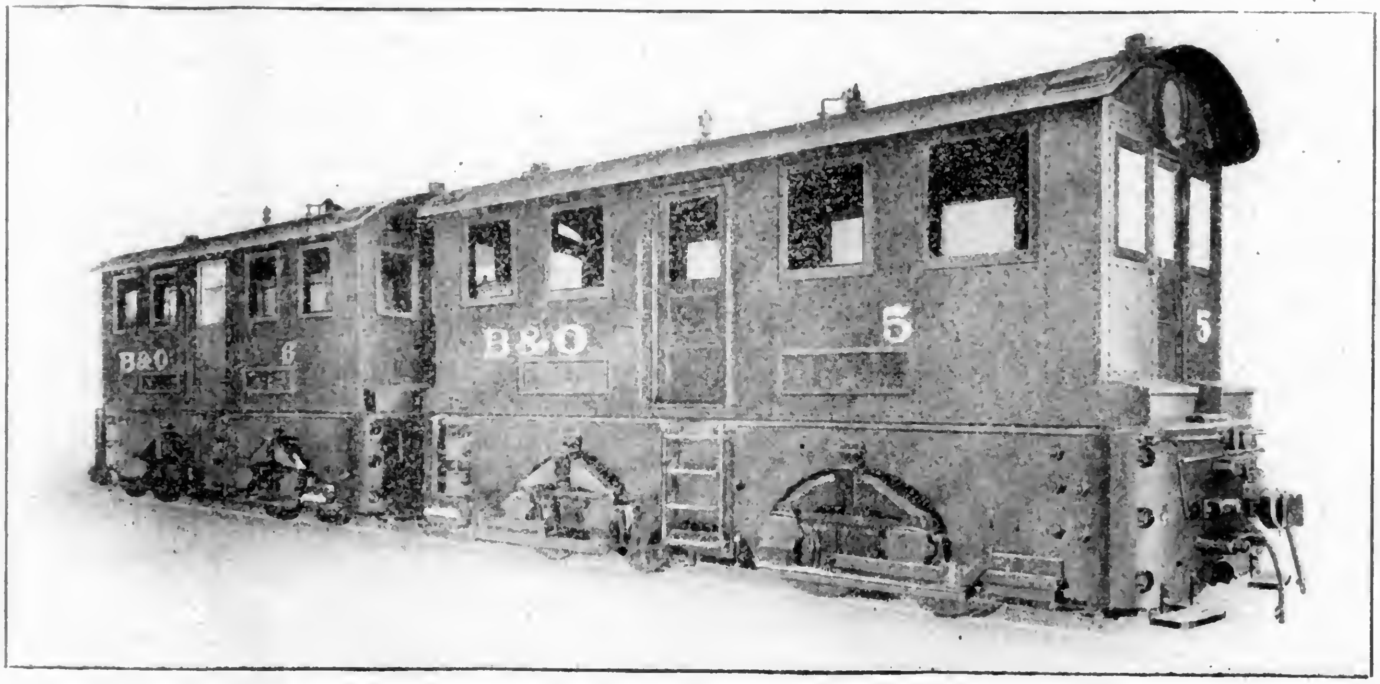
A NEW IDEA IN ELECTRIC LOCOMOTIVE DESIGN.

THE MULTIPLE-UNIT SYSTEM APPLIED TO HEAVY ELECTRIC TRACTION.

BALTIMORE & OHIO RAILROAD.

The General Electric Company has just turned out from its Schenectady Works an electric locomotive for the Baltimore & Ohio which is, in its entirety, the heaviest and most powerful locomotive ever built up to this time, whether steam or electrically propelled. It is intended for use in the peculiar class of service met in the Belt Line Tunnel of the Baltimore & Ohio at Baltimore, Md., where a third-rail system of electric traction has been in successful use for several years, as most of our readers well know.

The section of the Belt Line over which this locomotive will be operated extends from the Camden Street Station through the tunnel to the summit of the grade outside the tunnel, a distance of 3½ miles. It will handle all the freight traffic of the Baltimore & Ohio passing through Baltimore, in the same manner as the present electric locomotives, built by the General Electric Company, which have been in successful operation for the past eight years.



THE NEW MULTIPLE-UNIT ELECTRIC LOCOMOTIVE—THE HEAVIEST AND MOST POWERFUL LOCOMOTIVE EVER BUILT.
BALTIMORE & OHIO RAILROAD. GENERAL ELECTRIC CO., *Builders*.

The specifications called for an electric locomotive capable of handling a 1,500-ton train, including the steam locomotive, but excluding the electric locomotive, on a maximum grade of 1½ per cent., at 10 miles per hour, with corresponding higher speed on lighter grades. This required a locomotive weighing approximately 160 tons on the drivers for purposes of adhesion, so that the engineers of the General Electric Company decided that the most practicable scheme was to build an articulated locomotive consisting of two complete 80-ton units operated together as one locomotive by means of the Sprague-General Electric multiple-unit system of control. The result has been the locomotive illustrated in the engraving, and it promises from the first trials to more than meet the expectations of the designers.

The entire locomotive consists of eight G.E.-65 motors, four in each half-section. These motors have each a capacity of 225 h.p., making the total capacity of the locomotive 1,800 h.p. Each section is equipped with the multiple-unit system of control and is so arranged as to permit it to be operated independent of the other, or to operate as well when several sections are coupled together. The controlling apparatus for each section consists of master controllers, engineer's valves, etc., in duplicate, a complete set being located in diagonally opposite corners of each cab, so that the engineer can stand in the front end of the locomotive when running in either direction.

The cab is large and roomy. The floor rests on the truck frame, the lining floor being of 1¾-in. hard pine, tongued and grooved, and the upper floor of hard pine, ⅞ in. thick, tongued and grooved and laid in the opposite direction. The sides and roof of the cab are of sheet steel. There is an entrance door on each side, and at each end there is an additional door, which permits of ready communication between sections when coupled together. Large windows afford an unobstructed view in all directions.

Each section of the locomotive is equipped with a bell, a whistle, two locomotive headlights, Leach pneumatic track sanders and a complete air-brake equipment, including two engineer's valves and air gauges.

The main body of the truck frame consists of a rectangular framework of cast steel, built up strong and heavy, of four pieces, two side frames and two end frames. The parts are securely fitted by machining at the ends and bolted together, thus forming a very strong and rigid structure capable of withstanding the most severe shocks. The end pieces are very massive and form the buffer beams, and to which a standard draft gear is attached. The side frames have machined jaws protected by wearing shoes, between which the journal boxes slide.

The truck frames are supported at four points on equalizers. Each equalizer rests on a pair of half-elliptic springs, the ends of which are supported on top of the journal boxes through wearing plates. The journal boxes are made similar to standard car journal boxes, the parts, however, being larger and stronger. The brasses can be easily removed, and by dropping down the wearing shoes it is possible to remove a journal box complete without removing the wheels and axles or other parts of the truck.

In order that the locomotive may round curves easily, the axles are given considerable lateral movement in the journal boxes, it being practical to do this with the electric locomotive design and thus reduce the effective rigid wheel base. The wheels, axles or motors can be easily removed from the trucks by dropping into a suitably constructed pit or by raising the truck frame.

Each section of the locomotive has eight steel-tired spoked wheels. The tires are 2⅞ ins. thick, with M. C. B. standard tread and flange, and are securely held in place by approved fastenings. The axles are made of forged steel, turned throughout, 6 x 12 ins. in the truck journal-bearings, 8 ins. in the wheel fit and 7½ ins. in the motor bearings.

THE PROPER HANDLING OF THE TONNAGE RATING SYSTEM.

By R. S. Wickersham,

Assistant Engineer of Tests, Santa Fe Coast Lines.

The question of tonnage and tonnage rating is one which …s come rapidly into prominence in the last three or four …ars, and although much has been written on this subject in …e technical papers and has formed the topic of discussion at …any railway club meetings, still, on most railroads, it is far …om being worked on a satisfactory basis at the present time. …ne of the principal troubles has been that, when the cry went …p all over the country for a system of engine rating by the …nnage method, too many officials went into it without any …nowledge of the subject and, in their zeal, made the tonnage …eavier than has been found wise for the most economical …esults, both in engine and train service. Recently, however, … reaction has set in and the mistakes made in inaugurating …he system are being slowly rectified.

One of the most important rectifications that is slowly being made in a great many parts of the country is that of abolishing the double-header system, the economy of which, the writer believes, has never been fully demonstrated.

It is a fact generally admitted that whenever a division yard gets "blocked" the superintendent runs singlehead trains and in a short time has the yard clear once more. Again, with the heavy power that is being built at the present time, the tractive force that is developed by two engines is enormous, and the numerous light capacity cars still in existence are unable to stand the strain, especially if near the head end of the train. The writer knows of cases where there were as many as twelve break-in-twos in a doublehead freight train in running over one division, each engine on this train developing 40,000 lbs. tractive force. In such cases the overtime would more than offset the saving in train crews' wages, to say nothing of the damage to equipment.

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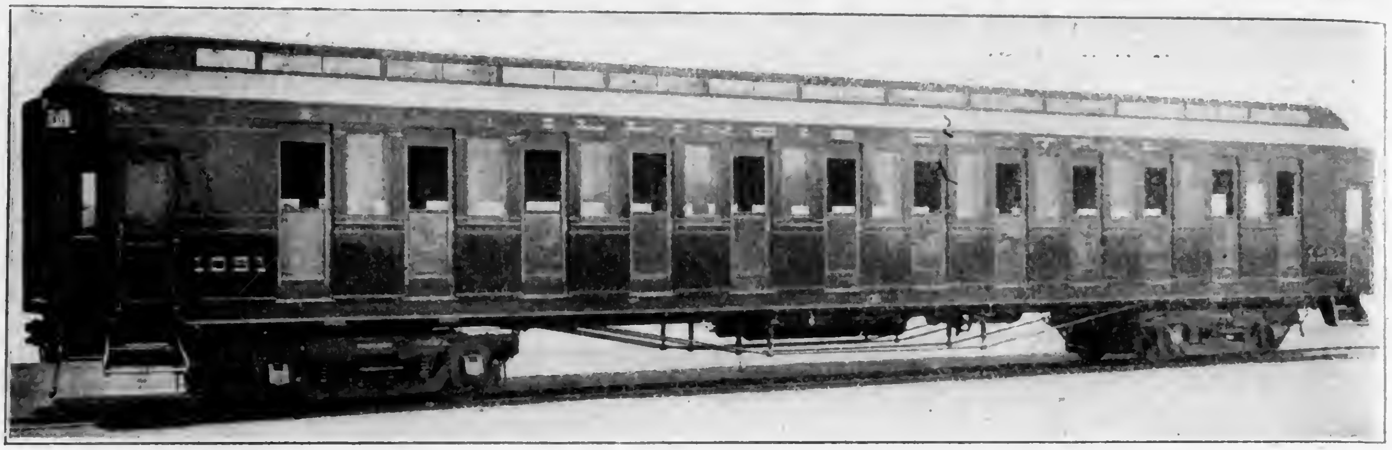
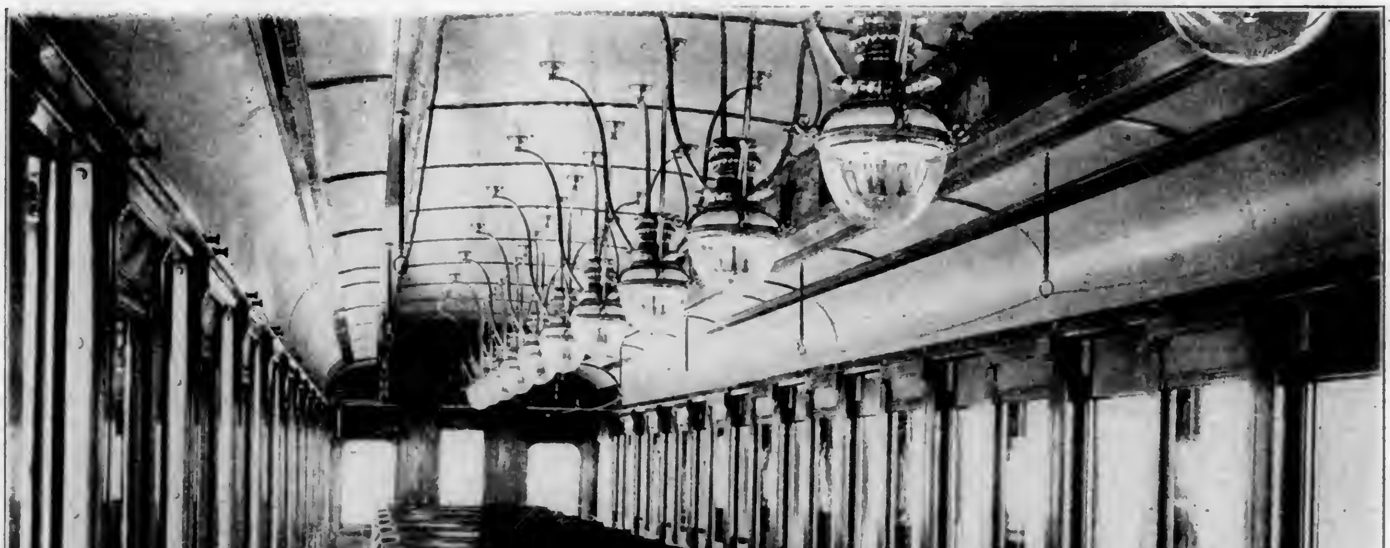


GENERAL VIEW OF CAR, SHOWING ARRANGEMENT OF SIDE DOORS.

VIEW OF CAR WITH SIDE DOORS OPEN, INDICATING LARGE EXIT CAPACITY.



INTERIOR VIEW OF CAR TO SHOW CENTRAL ARRANGEMENT OF SEATS.

NEW STEEL-FRAME, SIDE-DOOR SUBURBAN PASSENGER CARS.—ILLINOIS CENTRAL RAILROAD.

DESIGNED BY A. W. SULLIVAN AND WILLIAM RENSHAW.

STEEL FRAME SIDE-DOOR SUBURBAN PASSENGER CARS.

ILLINOIS CENTRAL RAILWAY.

II.

The interesting newly designed suburban passenger cars for the Illinois Central, which were described at length in our June, 1903, issue (pages 204-206), have recently been completed and are to be immediately placed in service in the important suburban service at the Chicago terminal. We are permitted to present photos herewith showing the general appearance of the exterior and interior of this interesting and novel design of car.

The unusual interest which attaches to these suburban passenger cars is due not entirely to the novel mechanical features developed in their design and construction, but even more to the effect this type of car is likely to have upon the question of the safe, rapid and efficient transportation of a dense passenger traffic, and especially to the protection against fire, resulting from the exclusive use of steel in the underframe. This question has become such an urgent one in all large cities that public interest is immediately concerned in any solution that offers intelligent and practical means of relief from the discomfort and dangers incident to the use of the end-door type of car of wooden construction, which, with all its other disadvantages, gives to the public the minimum of seating accommodation, with the slowest possible service in receiving and discharging passengers.

As indicated in the above mentioned article, the English idea of a side-door is used, but the method of its application is quite different; and, while utilizing the side-door principle, there is combined with it all the advantages of the central aisle peculiar to the American end-door car, thus producing a type of car having the advantages of both systems without their disadvantages, and of much greater seating capacity.

In this country, with the steadily increasing density of passenger traffic upon railroads having a suburban business, and particularly upon the elevated and subway lines handling a heavy metropolitan traffic, the limitations of the end-door cars have become too plainly apparent, as demonstrated by the unreasonable detentions of trains at stations in discharging and taking on passengers during the rush hours of the morning and evening. These detentions have a material influence in diminishing the earning capacity of the properties, to say nothing of the inconvenience to the public occasioned by the inability of the lines to afford the requisite accommodations. The remedy usually applied of increasing the number of trains at such times does not afford the desired relief, for the reason that no improvement can thus be effected in the crowding of passengers at the ends of the cars, with the incidental struggling efforts of many persons to gain immediate entrance through the narrow gateways and end-doors. The entire system is a defective one and must necessarily remain so, as it produces a concentration of passengers at the ends of cars and congests the passageways whenever the traffic becomes heavy, and the congestion continues to increase with the density of traffic until finally the blockade is complete and movement ceases.

In these circumstances it is evident that the remedy lies in preventing the formation of the crowded groups at the ends of cars, and of distributing the passengers evenly over the entire length of the station platform, so that when trains arrive they may step directly and conveniently from the platform to the side-doors of the cars and avoid the uneasy movement up and down the platform to get opposite the end entrances at their more or less uncertain points of stoppage. Such distribution can be effected only by the use of cars having a sufficient number of side-doors so that there is no choice of position on the station platforms when awaiting trains. This result is obtained only in these new cars, which have 12 sliding side-doors on each side, each door being directly opposite a section of eight seats and spaced 5 ft. from center to center throughout the length of the car, which also has double aisles located on both sides just inside of the doors and extending the entire length of the car.

The numerous advantages of this method of transportation are shared alike by the passengers and the company. The absence of the crowding and the necessary struggling to gain entrance to the car, and the nearly double number of seats readily accessible than are to be found in an ordinary car, are changed conditions readily appreciated by the passengers, while the rapidity of the movement of receiving and discharging passengers will materially facilitate train movement and increase the transportation capacity of the road. As between an end-door and a side-door car the relative quickness of movement in receiving and discharging passengers is represented by the relation of the length to the width of the car and the number of doors available. In a car 60 ft. in length with two end-doors, passengers may leave the car in a single file at the rate of one per second from each door, requiring 30 seconds to empty the car, whereas in a car 10 ft. in width with 12 side-doors, passengers may leave the car at the rate of one per second from each door, requiring but 5 seconds, or one-sixth of the time to discharge the same number of passengers.

When in addition to these advantages, to the fireproof qualities, and to the impossibility of telescoping in case of collision, it is considered that the steel-frame car is from 6,000 to 10,000 lbs. lighter than cars of the same size of the standard wooden construction, it will be readily seen that a great advance has been made not only in the art of car construction, but what is perhaps of greater importance—it makes possible a pronounced improvement in the methods of passenger transportation.

This new type of car is the result of careful study, based upon long experience in the handling of a large suburban traffic on the part of Mr. A. W. Sullivan, assistant second vice-president, and of Mr. William Renshaw, superintendent of machinery, of the Illinois Central Railroad, who have designed the many original features embodied in these new cars, and to whom we are indebted for this information. Further interesting details of the cars will appear in our next month's issue.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

Report by Professor W. F. M. Goss.

XIX.

(*Concluded from Page* 304.)

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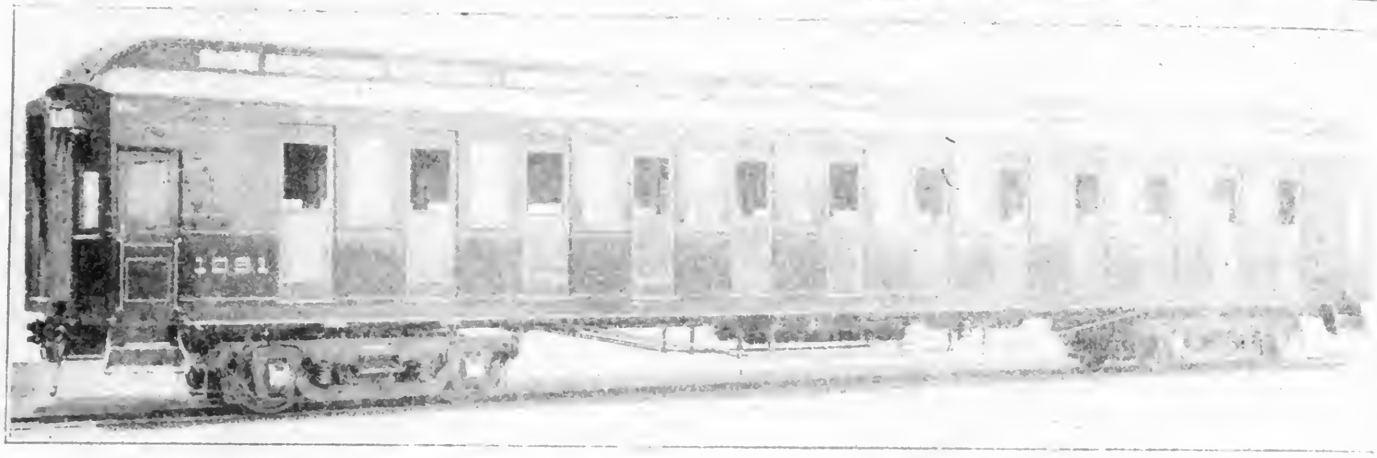
The use of an inside stack pre-supposes a low nozzle, and for this reason, three heights of nozzle only were experimented upon, namely, No. 3 nozzle, the tip of which is on the center of the boiler; No. 2 nozzle, the tip of which is 5 ins. lower; and



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(Concluded from Page 304.)

The stacks and nozzles experimented upon are shown by Fig. 107. The stack was made of sheet iron in such form as to slide within one of the bases which had been used in connection with the previous work. Set screws inserted around the lower part of the base assisted in centering the stack, and after each adjustment in height, the joint between the stack and the base was carefully packed to avoid leakage. In its highest position the top of this stack was at the same point as that reached by the "D" stack employed in experiments with outside stacks. The length of the straight portion was constant and equal to 58 ins., the total length including the flaring portion at the lower end being 64 ins. In the course of the experiments, the position of this stack was changed from the highest, as shown, to positions 10, 20 and 30 ins. lower, bringing its upper end to a position agreeing with the top of the outside stacks C, B and A, respectively. It should be noted that throughout the experiments, the total length of the stack tube remained unchanged, and also, that no change was made in the flaring portion at the bottom.

The use of an inside stack pre-supposes a low nozzle, and for this reason, three heights of nozzle only were experimented upon, namely, No. 3 nozzle, the tip of which is on the center of the boiler; No. 2 nozzle, the tip of which is 5 ins. lower; and

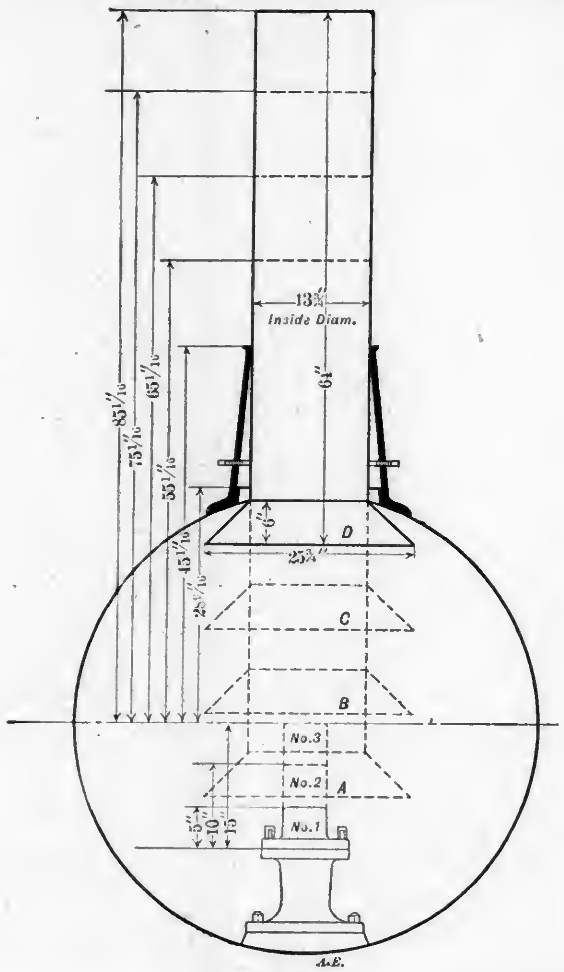
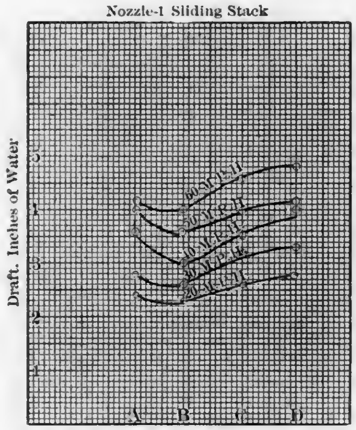


Fig. 107.

the exhaust nozzle and the base of the stack when the latter is in its highest (D) position, is the same as that between the lowest exhaust nozzle and the base of the stack when the latter was in its position (C). It appears, however, that notwithstanding this agreement between the relative position of tip and base of stack, draft values are higher for the higher tip (Fig. 110). Again, with this tip and the third position of the stack (B) we have the same relative position of tip and stack as existed between the lowest nozzle and the lowest position of stack (A), so that, if much depends upon the relative position of stack and tip B, results in Fig. 110 should agree with the A results in Fig. 108, and as a matter of fact, there is a rather close agreement in these results. Finally, it is of interest to note that with the highest tip and the lowest stack, when the tip is well into the body of the stack (position A, Fig. 107), draft values are less satisfactory than under any other condition.

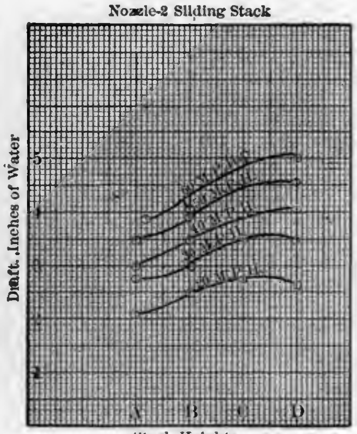
The general conclusion to be derived from these results is

Nozzle-1 Sliding Stack



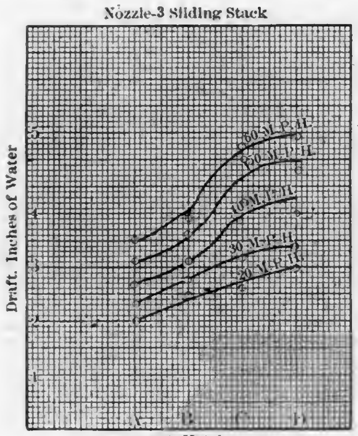
Stack Heights
Fig. 108

Nozzle-2 Sliding Stack

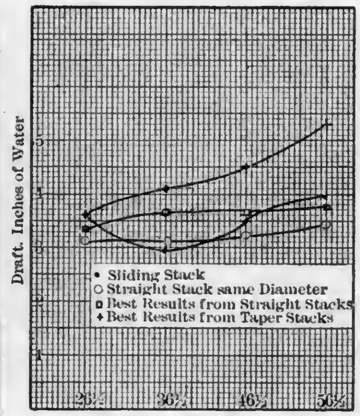


Stack Heights
Fig. 109

Nozzle-3 Sliding Stack

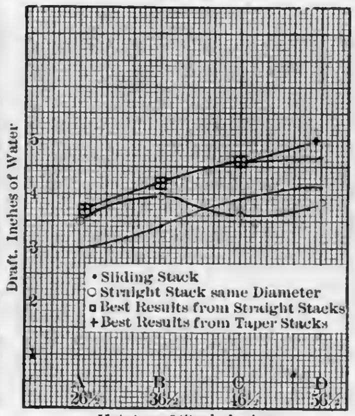


Stack Heights
Fig. 110



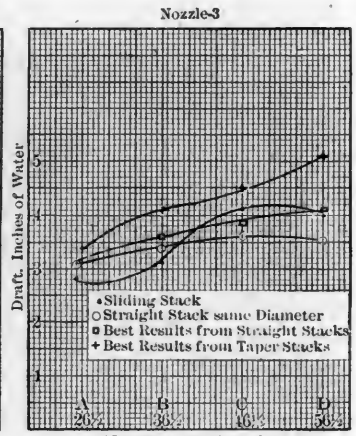
Heights of Stack, Inches
Fig. 111

Nozzle-2



Heights of Stack Inches
Fig. 112

Nozzle-3



Heights of Stack Inches
Fig. 113

No. 1 nozzle, the tip of which is 10 ins. lower. Tests were made in connection with each height of nozzle for each position of the stack. Only one diameter of stack was experimented upon. The results obtained for speeds of 20, 30, 40, 50 and 60 miles, respectively, are given in Tables VI. to XIII., inclusive, and are shown graphically in Figs. 108, 109 and 110.

Referring first to Fig. 108, representing results obtained from the lowest nozzle, it will be seen that the draft was best when the stack was at its highest point, and that it diminished as the stack was lowered, until in the process of lowering the stack, its lower edge approached very close to the exhaust nozzle. For the lowest position of the stack, for which but a trifle more than an inch intervened between the lower edge of the stack and the top of the nozzle, there is an increase in the draft value. Fig. 109, showing the results obtained in connection with the No. 2 nozzle which, for the lowest position of the stack, is actually inside of the stack itself, gives results somewhat similar. Fig. 110 is perhaps most interesting in comparison with Fig. 108. In Fig. 110, the exhaust nozzle is on the center line of the boiler, and the distance between the top of

to the effect that in changing the amount which the stack projects, it is not possible to maintain a constant stack efficiency by allowing the stack to project into the boiler to an amount equal to the reduction in its outside length.

We may next inquire whether there is any advantage in allowing the stack to project inside the boiler, as compared with results obtained with varying lengths of stack outside. For this study, reference should be made to Figs. 111, 112 and 113, upon which are plotted results obtained at a speed of 40 miles an hour; first, from the sliding stack; second, from a straight stack of the same diameter and of a height equal to the outside projection of the sliding stack; third, from the best results obtained from any straight stack of the height specified, the diameter agreeing, or not agreeing with that of the sliding stack; and, fourth, the best results obtained from a tapered stack of the several heights specified, regardless of its diameter. To properly interpret these results, one needs to construct, either actually or mentally, a picture of the stack conditions applying in each case. It will be of general interest to note that the outside straight stacks experimented upon were

not sufficiently large for results of maximum efficiency except for the very shortest length employed. In view of this fact and in view, also, of the fact that the straight stack of the same diameter when used in the B, C and D heights did not give as good results as straight stacks of greater diameter, it may be questioned whether the diameter of the sliding stack was well chosen for maximum results. It is clear, however, that the results as shown by Figs. 111 to 113 do not constitute a strong argument for the inside stack, since better results are obtained for straight stacks of the same diameter when the latter are of short length, and since it is shown to be easily possible to so proportion the diameter and length of an outside stack, even when the projecting heights are necessarily small, as to give better results than those representing the inside stack.

While the conclusion thus presented seems to be fairly justified by the experimental data, it should not be accepted as conclusive. The problem of the inside stack is one of many variables. The work already accomplished hardly does more than to suggest the difficulties to be met in reaching a satisfactory conclusion. Before the inside stack can be solved, much attention will need to be given to its form at the lower end.

It should further be noted that it is the practice of many roads using inside stacks to construct a false top to the smokebox, thereby imposing such conditions as to make the stack in effect entirely an outside stack. This is a condition which should be embraced by a further study of the subject, and until experiments can be conducted, which can involve as liberal a plan as that which has now been completed upon outside stacks, it will be rather unsafe to predict performance. Meantime, the writer would say that his discussion before the Master Mechanics' Association in June concerning the advantages of the inside stack, which was based upon a preliminary and altogether superficial study of the data, seems not to have been entirely justified.

[Editor's Note.—At this point the report was interrupted in order to present the formulæ in the June issue.]

SECTION IX.

50. *Acknowledgments.*—Having now completed the description of this research it is fitting that some specific mention be made of those who have been concerned with its advancement. The locomotive laboratory of Purdue University was installed primarily for the instruction of students. As it is an expensive plant to operate, and as the trustees of Purdue have had but little money which could be used in meeting laboratory expenses, it has been found impracticable to keep the plant continuously occupied. It has in fact been idle approximately two-thirds of the time throughout its eleven years' existence. Being impressed with the importance of results which are to be obtained by its use, the undersigned has made repeated efforts to prolong its working periods. When, therefore, the American Engineer proposed an important research, with a pledge covering the cost of same, its offer was promptly and gladly accepted. The research contemplated has long since been finished and all results have now been published. Viewing the undertaking as one of scientific achievement, it is evident that a large part has been taken by the American Engineer, and it is to this journal, therefore, that formal acknowledgment should first be made. Not only has the American Engineer supplied funds sufficient to meet all ordinary expenses incident to the active operation of Purdue's locomotive laboratory for the larger part of a year, but it has opened its columns to a long and somewhat technical report, reproducing with a lavish hand all figures and diagrams which have been submitted for its consideration.

It is fitting, also, that reference be made to the indulgence extended by the editor of the American Engineer. In the prosecution of the work difficulties were encountered which could not have been foreseen. The undertaking was not of sufficient extent to warrant an increase in the permanent staff of the laboratory nor has it been practicable to employ outside expert assistance. As a consequence, the work was entirely assumed by an organization previously heavily loaded with routine work, upon some members of which the burden has borne heavily, with the result that while the tests were run with reasonable promptness, the task of summarizing data and formulating the report proceeded more slowly, so slowly, in fact, that more than a year has elapsed between the initial steps of the experiments and the completion of the concluding portion of this report. While the editor has not complained, it is evident that there can be no justification for such delay except such as may be found in the necessities of the situation.

It is but proper to mention, also, that while the American Engineer proposed and executed, and has done this most liberally, the authorities of the university, also, in prescribing the conditions under which the tests were to proceed have in effect made important contributions to its progress. To the trustees of Purdue University, therefore, much credit is due.

The undersigned is especially indebted to Prof. Edward E. Reynolds, under whose immediate direction the work of the laboratory was carefully and vigorously advanced, and who, more than any other, has devoted himself to the work of summarizing data, and in drafting portions of the report; also, to Professor William Forsyth, who, while associated with the university, gave generous attention to all matters of design, and whose special study of existing stacks, as presented in a section of this report, is elsewhere acknowledged. Credit is also due members of the senior class of "'02" in the department of mechanical engineering, who, as expert observers, assisted in manning the laboratory, and especially to Messrs. E. Brock, L. Huxtable, J. P. Cook and J. C. McGrath, who presented graduating theses covering some portion of the investigation, the result of whose labors has been of material aid to the undersigned in the preparation of this report.

Others who have contributed to the success of the work, but who perhaps have rendered their aid more directly to the American Engineer than to the undersigned, are as follows: The Lake Shore & Michigan Southern Railway Company, by the courtesy of Mr. W. H. Marshall, general superintendent, in supplying the experimental stacks and nozzles; the Snow Steam Pump Works in supplying oil-feeding device; the Standard Oil Company for the loan of oil tank and for courtesy in connection with supplying fuel oil; the Atchison, Topeka & Santa Fe Railway Company, by Mr. G. R. Henderson, superintendent of motive power, for supplying oil burner; and the Claybourne Oil Burner Company, 1770 Old Colony Building, Chicago, Ill., for supplying oil burner.

Respectfully submitted,

W. F. M. Goss.

Engineering Laboratory, Purdue University, Jan. 10, 1903.

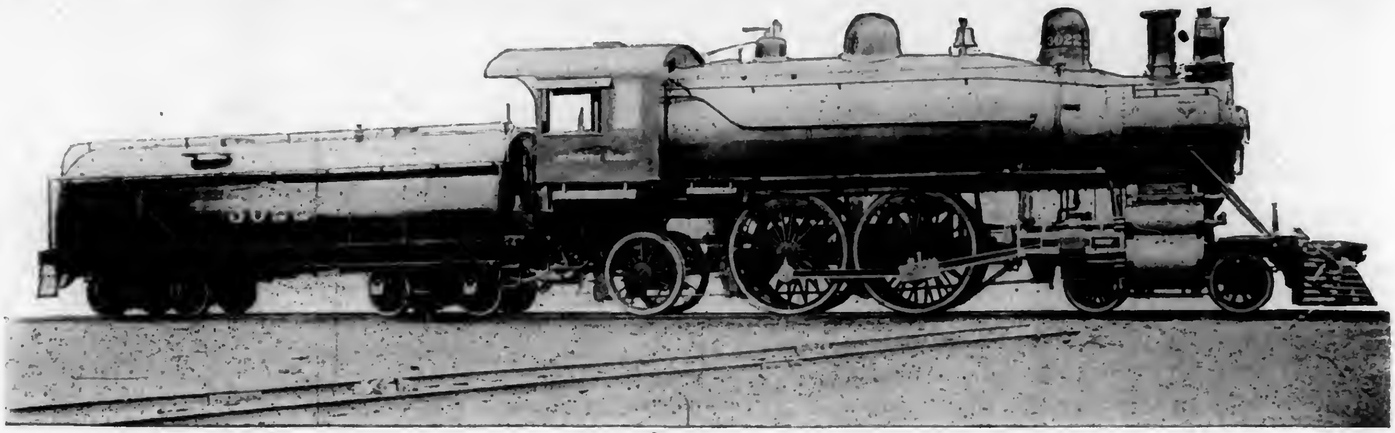
[Editor's Note.—This is the conclusion of the report by Professor Goss and completes the record of the tests up to date.

OIL-BURNING PASSENGER LOCOMOTIVE.

Vauclain Compound 4—4—2 Type.

SOUTHERN PACIFIC RAILWAY.

This is the first locomotive of the 4—4—2, or Atlantic, type from the Baldwin Locomotive Works having the main road connected to the leading driving wheels. The wheel base for the locomotive alone is 31 ft. 3½ ins., which is longer than that of any other four-coupled locomotive in our record. Its total wheel base of locomotive and tender is 65 ft. 5¼ ins., which is more than 3 ft. longer than the wheel base of the two enormous decapods of the Santa Fe. The new Southern Pacific engine has a Vanderbilt firebox, arranged for burning oil and containing a departure in the form of a water leg at the back end of the firebox. The back end of the boiler tapers sharply to the back head, whereby considerable weight is saved and the cab is made more roomy. This road has adopted semi-circular tanks for the tenders of oil-burning engines. The one shown in the engraving carries 7,300 gals. of water and 3,300 gals. of oil. The construction of



NEW OIL-BURNING PASSENGER LOCOMOTIVE.—SOUTHERN PACIFIC RAILWAY.
VAUCLAIN COMPOUND.—4-4-2 TYPE.

these tenders was illustrated in this journal in November, 1902, page 350. The wheel base of this tender is 24 ft. 4 ins.

The tractive power as a compound is 21,690 lbs., and with the starting valve open it is increased to 24,000 lbs. The following are the ratios or capacity factors, and the appended table presents the leading dimensions:

RATIOS.

Heating surface to volume of high-pressure cylinder	=	531.
Tractive weight to heating surface	=	33.6
Tractive weight to tractive effort	=	4.71
Tractive effort to heating surface	=	7.14
Tractive effort × diameter of drivers to heating surface	=	564.
Heating surface to tractive effort	=	14%
Total weight to heating surface	=	65.8

4—4—2 Type Passenger Locomotive.
Southern Pacific Railway.

Gauge	4 ft. 8½ ins.
Cylinder	15 ins. and 25 ins. x 28 ins.
Valve	Balanced piston
Boiler—Type	Wagon top
Material	Steel
Diameter	66 ins.
Thickness of Sheets	11-16 and ¾ in.
Working pressure	200 lbs.
Fuel	Oil
Firebox—Material	Steel Vanderbilt
Length	121 ins.
Diameter	63⅜ ins.
Thickness of tube sheets	½ in.
Tubes—Material	Steel. Wire gauge, 125 mm.
Number	346
Diameter	2 ins.
Length	16 ft.
Heating Surface—Firebox	155 sq. ft.
Tubes	2,883 sq. ft.
Total	3,038 sq. ft.
Driving Wheels—Diameter outside	79 ins.
Diameter of center	72 ins.
Journals	9 x 12 ins.
Engine Truck Wheels (Front)—Diameter	36¼ ins.
Journals	6 x 10 ins.
Trailing Wheels—Diameter	54¼ ins.
Journals	8½ x 12 ins.
Wheel Base—Driving	6 ft. 10 ins.
Rigid	15 ft. 10 ins.
Total engine	31 ft. 3½ ins.
Total engine and tender	65 ft. 5¼ ins.
Weight—On driving wheels	102,190 lbs.
On truck, front	61,620 lbs.
On trailing wheels	36,220 lbs.
Total engine	200,030 lbs.
Total engine and tender	About 340,000 lbs.
Tank—Capacity	Water, 7,300 gals.; oil, 3,300 gals.
Tender—Wheels	Number, 8; diameter, 33½ ins.
Journals	5½ x 10 ins.

MACHINE TOOL PROGRESS.

Feeds and Drives.

IX.

BY C. W. OBERT.

Another interesting variable-speed driving mechanism for a radial drill is illustrated in this article. The Mueller Machine Tool Company, Cincinnati, Ohio, have appreciated the importance of providing a wide range of speeds for the drive upon their drill, the result being the interesting variable-speed device described below. By means of this mechanism and the spindle back-gear the operator of the Mueller radial has at his command a range of 16 different speeds, all easily obtainable.

The new speed-box is illustrated in the engraving, Fig 44,

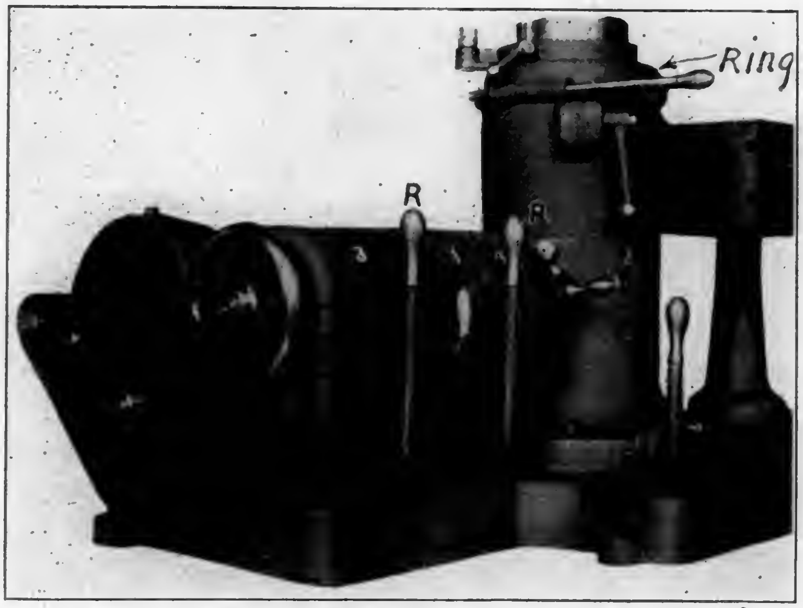


FIG 44.—VIEW OF THE SPEED BOX APPLIED IN CONJUNCTION WITH AN ELECTRIC DRIVE TO THE MUELLER RADIAL DRILL.

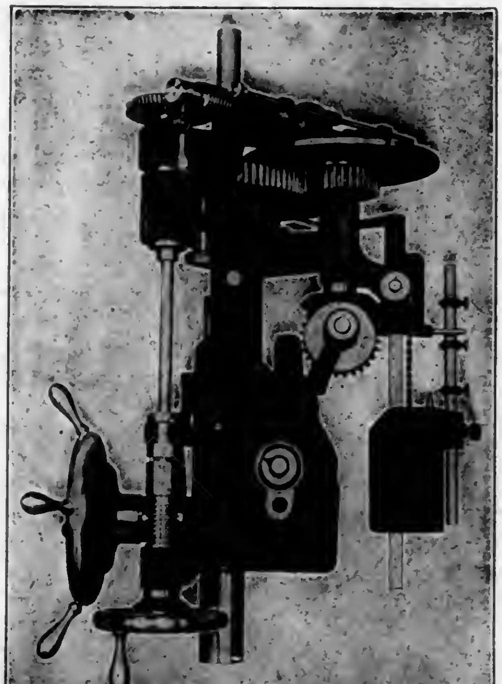
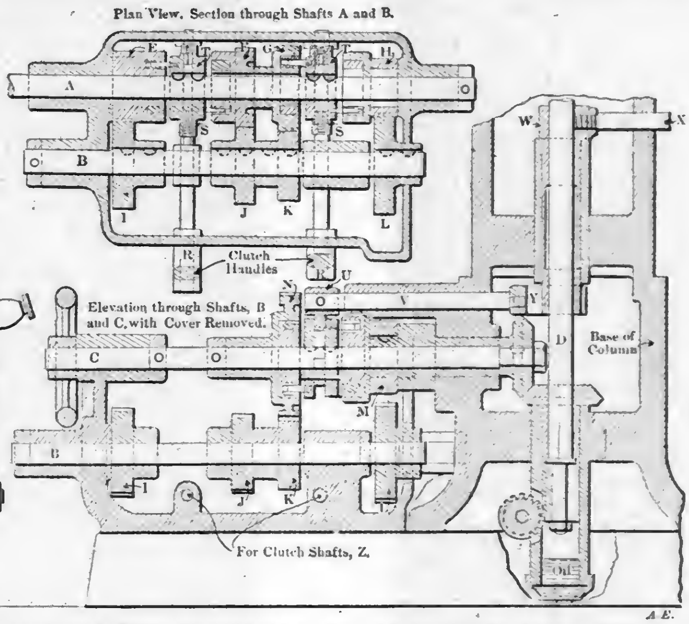


FIG. 46.—END VIEW OF HEAD UPON ARM, SHOWING FRICTION-PLATE FEEDING MECHANISM.

on the opposite page, in which the drive snown for the drill is an electric motor operating through a gear train enclosed in a dust-proof case. The general view of the Mueller radial, Fig. 46, below, does not show the new speed-box applied. The principle upon which the variable-speed mechanism operates is made clear in the drawing reproduced at the right, Fig 45.

The driving shaft for this mechanism is shaft, A, and the delivery shaft, driving the drill is shaft, C, shaft, B, being an intermediate. Upon shaft, A, are mounted loosely the four gears, E, F, G and H, upon each of which gears is mounted a friction clutch for driving from the shaft. These loose gears mesh with gears, I, J, K and L, respectively, which are all keyed upon shaft, B, so that whenever a gear on shaft, A, is thrown in clutch, shaft, B, is driven at a different speed; this provides four speeds. Then, as may be seen from the end view, the drive is made from shaft, B to C, either through gears, K-N, or through gear train, L-P-Q-M, according as friction clutch, U, is thrown to the left or the right. This makes eight speeds available in the speed-box.



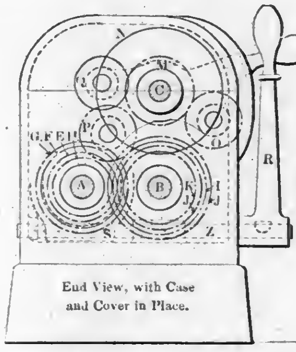


FIG. 45.—DETAILS OF THE VARIABLE-SPEED MECHANISM FOR THE MUELLER RADIAL DRILL.

The friction clutches controlling the four gears on shaft, A, are operated by the two lever handles, R, outside, which shift the wedges, T-T, by means of trunnions, S. These clutches are of the spring ring type, insuring smoothness of action in starting. The small lever shown on the front of the box is for the purpose of locking either one of the levers, R, while the other is in use, this being to prevent the accidental throwing of two gears in clutch on shaft, A, at the same time. The numbers, 1, 2, 3 and 4, on the case indicate the positions to which the levers, R, must be thrown for the various speeds available thereby, 1 being the fastest and 4 the slowest speed of that group.

Friction clutch, U, which governs the two speed ranges, is also used for starting and stopping the drill spindle. It is controlled from outside by a starting lever extending from the loose ring shown encircling the column above the swinging table, which ring engages with rod, X, shown in the drawing. As this ring is turned, sleeve, W, is turned and by a pinion at its lower end moves rack, Y, and, with it, rod, V. Thus, as the ring is thrown to the right or left, either the slow or fast train of gears is clutched to shaft, C, by U.

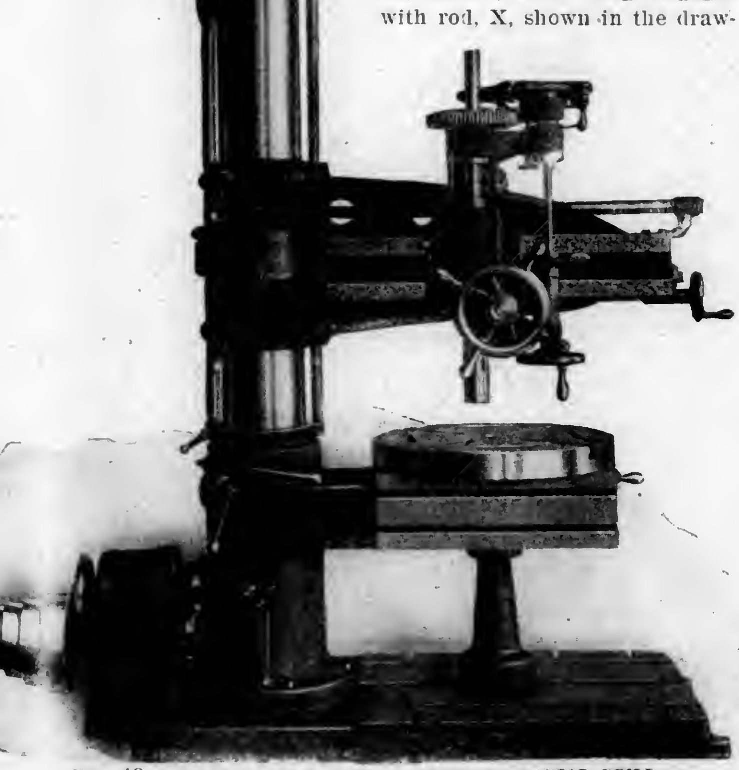


FIG. 48.—GENERAL VIEW OF THE MUELLER RADIAL DRILL.

Another feature of this portion of the mechanism is that of a double-throw train of gears between gears, L and M, by means of which a reversal of motion is permitted. These gears are carried on a tumbler as is made clear in the end view. Normally the drive is through L-P-Q-M, but by shifting the tumbler handle, gears P-Q are lifted up and gear, O, dropped into mesh with L, making the drive through L-O-M. This is a very convenient method of reversal for use in tapping, etc.

The starting lever is also used to control the power raising

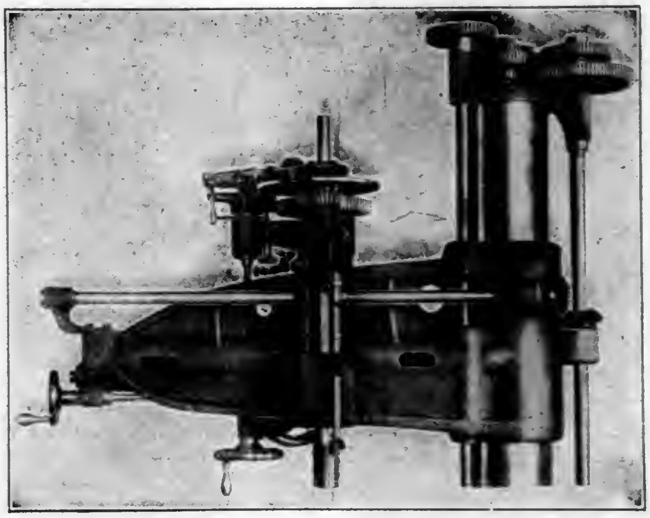
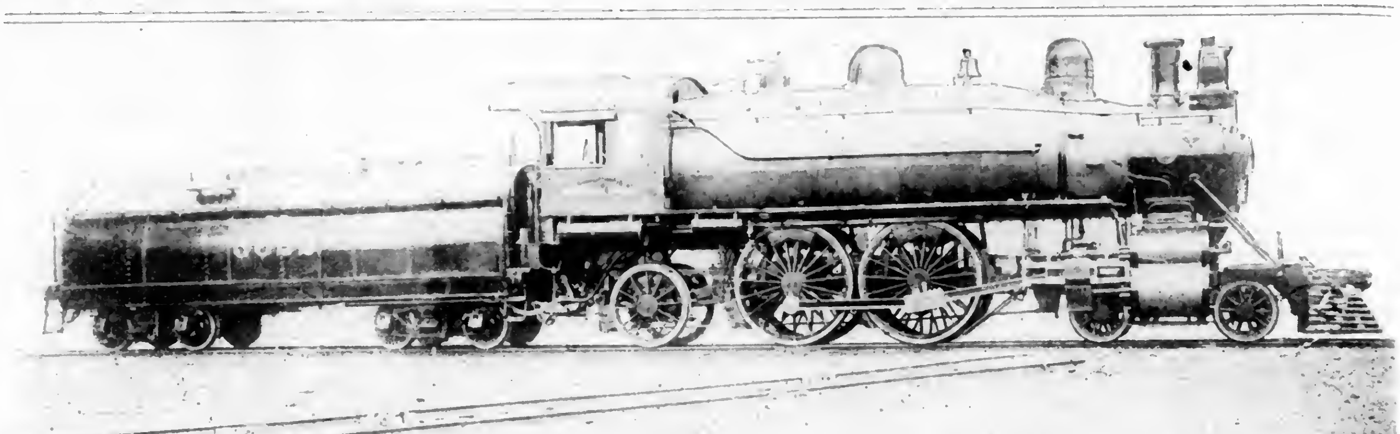


FIG. 47.—REAR VIEW OF HEAD UPON ARM, SHOWING DETAILS.

and lowering of the arm, as well as the stopping and starting of any of the entire range of speeds. When this clutch is thrown out the lower driving shafts, A and B, are the only ones in motion, thus reducing to a minimum the wear.

The variable-speed feeding device used upon the Mueller radial is a friction plate and disc, the location of which is made plain in Figs. 46 and 47. The friction disc is easily moved across the plate for changes of feeding speed, which may be made when the drill spindle is in operation. By moving the disc from the center to the rim of the plate, feeds from 0 to .023 in. per revolution of the spindle may be obtained. The drive for the automatic feed is made through a jaw clutch on the shaft carrying the worm which drives the gear on the feed shaft.



NEW OIL-BURNING PASSENGER LOCOMOTIVE.—SOUTHERN PACIFIC RAILWAY.
VAUCLAIN COMPOUND.—4-4-2 TYPE.

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Trailing Wheels—Diameter	51¼ ins.
Journals	8½ x 12 ins.
Wheel Base—Driving	6 ft. 10 ins.
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MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

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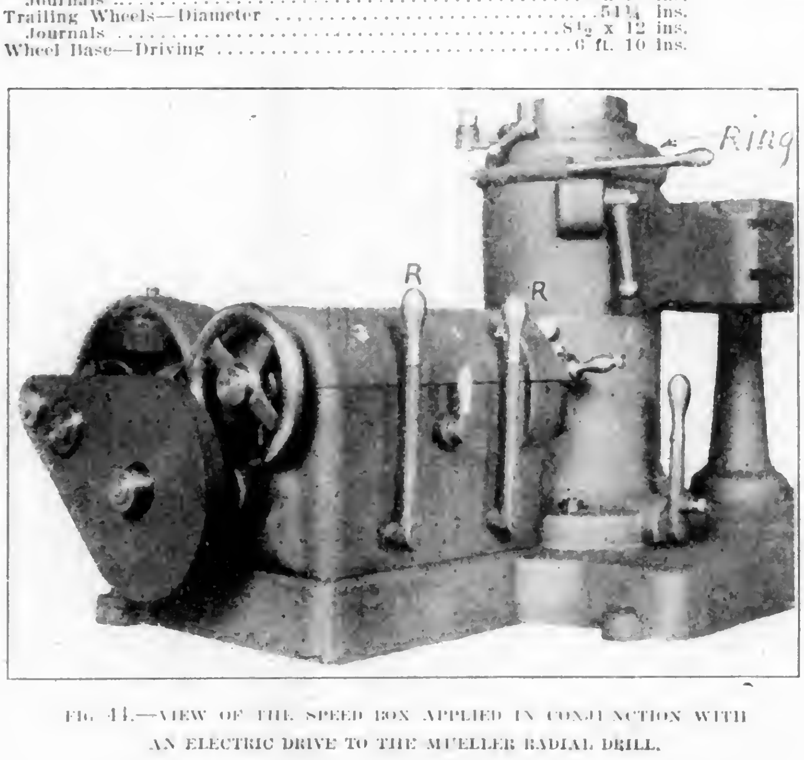
The new speed-box is illustrated in the engraving, Fig 44,



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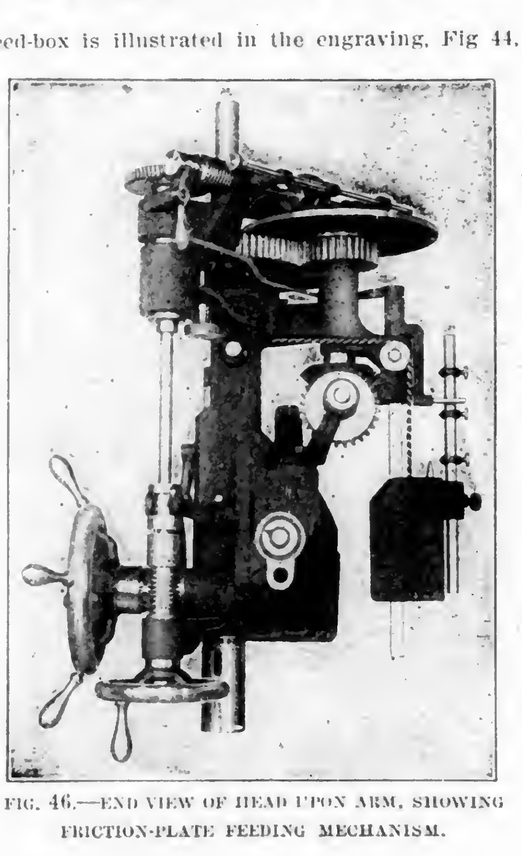

FIG. 46.—END VIEW OF HEAD UPON ARM, SHOWING FRICTION-PLATE FEEDING MECHANISM.

the opposite page, in which the drive shown for the drill is electric motor operating through a gear train enclosed in a st-proof case. The general view of the Mueller radial, Fig. below, does not show the new speed-box applied. The nciple upon which the variable-speed mechanism operates made clear in the drawing reproduced at the right, Fig 45.

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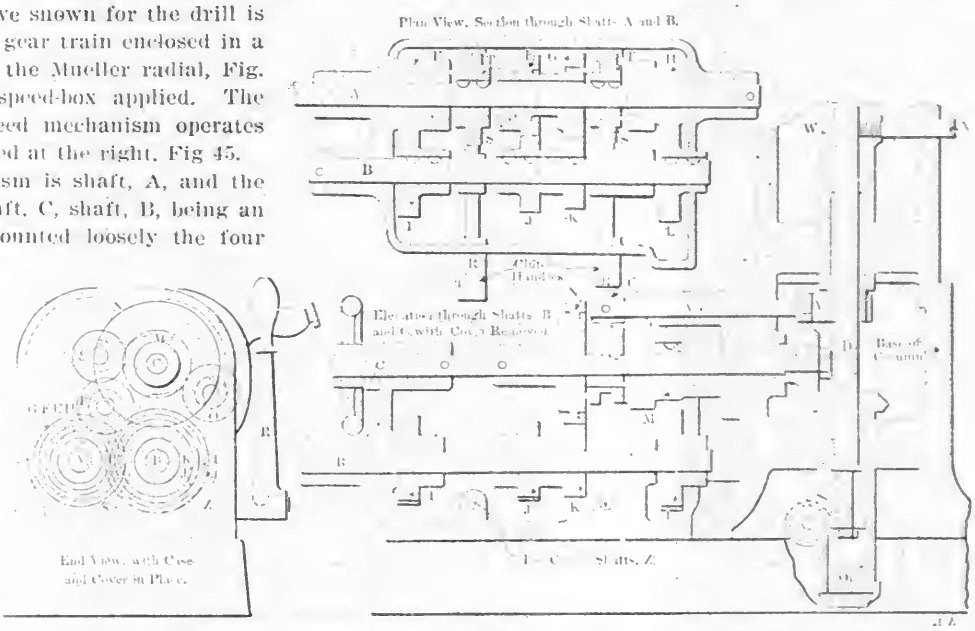

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The friction clutches controlling the four gears on shaft, A, are operated by the two lever handles, R, outside, which shift the wedges, T-T, by means of trunnions, S. These clutches are of the spring ring type, insuring smoothness of action in starting. The small lever shown on the front of the box is for the purpose of locking either one of the levers, R, while the other is in use, this being to prevent the accidental throwing of two gears in clutch on shaft, A, at the same time. The numbers, 1, 2, 3 and 4, on the case indicate the positions to which the levers, R, must be thrown for the various speeds available thereby, 1 being the fastest and 4 the slowest speed of that group.

Friction clutch, U, which governs the two speed ranges, is also used for starting and stopping the drill spindle. It is controlled from outside by a starting lever extending from the loose ring shown encircling the column above the swinging table, which ring engages with rod, N, shown in the drawing. As this ring is turned, sleeve, W, is turned and by a pinion at its lower end moves rack, Y, and, with it, rod, V. Thus, as the ring is thrown to the right or left, either the slow or fast train of gears is clutched to shaft, C, by U.

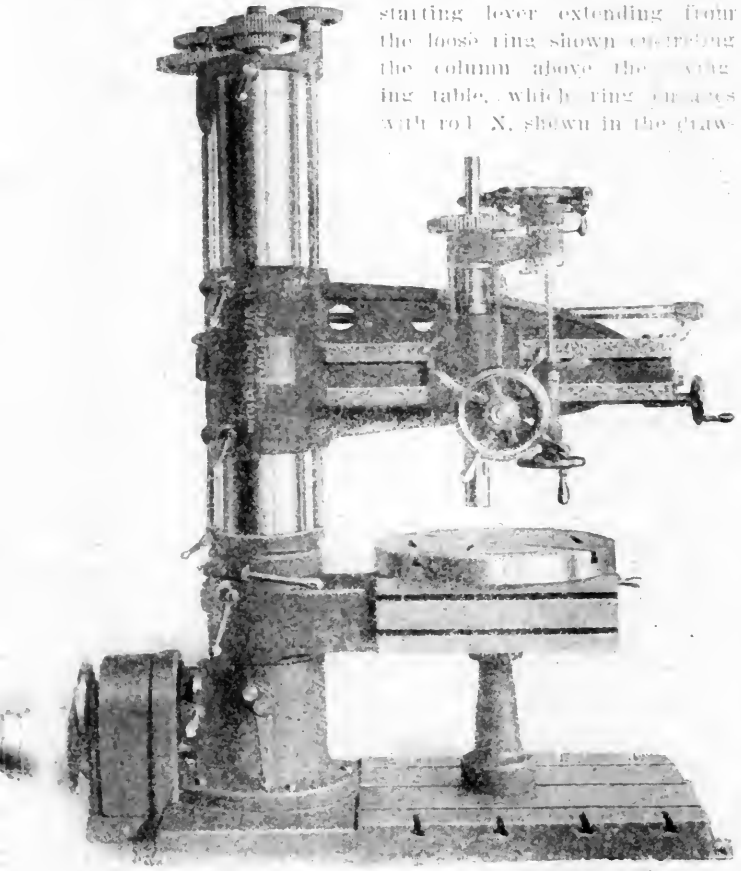

FIG. 48.—GENERAL VIEW OF THE MUELLER RADIAL DRILL.

Another feature of this portion of the mechanism is that of a double-throw train of gears between gears, L and M, by means of which a reversal of motion is permitted. These gears are carried on a tumbler as is made clear in the end view. Normally the drive is through L-P-Q-M, but by shifting the tumbler handle, gears P-Q are lifted up and gear, O, dropped into mesh with L and M, giving the drive through L-O-M. This is a very convenient ... reversal for use in tapping, etc.

The starting lever is also used to control the power raising

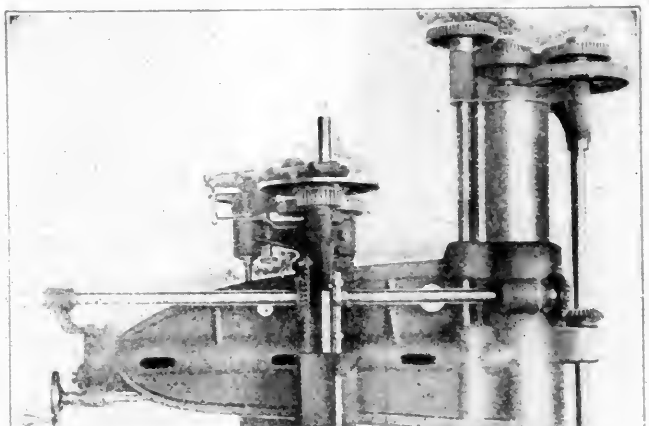

FIG. 47.—REAR VIEW OF HEAD UPON ARM, SHOWING DETAILS.

and lowering of the arm, as well as the stopping and starting of any of the entire range of speeds. When this clutch is thrown out the lower driving shafts, A and B, are the only ones in motion, thus reducing to a minimum the wear.

The variable-speed feeding device used upon the Mueller radial is a friction plate and disc, the location of which is made plain in Figs. 46 and 47. The friction disc is easily moved across the plate for changes of feeding speed, which may be made when the drill spindle is in operation. By moving the disc from the center to the rim of the plate, feeds from 0 to .023 in. per revolution of the spindle may be obtained. The drive for the automatic feed is made through a jaw clutch on the shaft carrying the worm which drives the gear on the feed shaft.

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EDITORIAL ANNOUNCEMENTS.

Advertisements. *Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

AN ADVANCE STEP IN SUPERHEATING.

If superheated steam can be used successfully in locomotives its introduction appears to be the most important improvement now at hand. An experimental application has given excellent results on the Canadian Pacific Railway for about two years, and Mr. Williams expresses his opinion of the idea in the practical form of two new locomotives which are to be fitted with superheaters. One of these is building at the Schenectady Works of the American Locomotive Company and the other in Scotland. These embody new construction, which is illustrated in this issue. This plan seems likely to prove entirely successful, and if so it will mark a distinct step in advance in the use of superheated steam. Mr. Williams is entitled to the credit of introducing superheating to the locomotive practice of this continent. Readers are urged to watch this development carefully.

THE NEW MULTIPLE UNIT ELECTRIC LOCOMOTIVE.

The design of the new electric locomotive that is soon to go in service upon the Belt Line Tunnel section of the Baltimore & Ohio, and which is illustrated on another page of this issue, is remarkable for being the first application of the multiple unit idea to heavy electric haulage. There are many advantages of this method over that of placing all the power and weight in one unit: the weight is distributed more evenly over the track, the individual units are smaller and less cumbersome, and, the most important of all, the locomotive may be increased in size indefinitely by the mere addition of more units to the group—in this way all the advantages of double-heading are obtained without the disadvantages. The multiple unit system permits any number of units to be grouped together and all operated and controlled simultaneously from one point on the train. This is an important move in the problem of simplification of the movement of heavy trains and will be watched with interest.

The design of each unit seems also to be entirely rational and practical. It is absolutely unhampered by the limiting conditions of steam locomotive practice, having been designed from a knowledge of and experience with the best electric railway practice of to-day. Cast steel frames of massive design were chosen, which furnish, besides great strength, the required weight for adhesion. Liberal provision has been made for ease of making necessary repairs, and inspection of the motors, trucks, etc., is made easy by the under-floor construction. The design seems altogether very commendable and the results in service will be of great interest in view of the proposed electrification of the New York terminals of the New York Central and Pennsylvania systems.

PROGRESS IN GRINDING.

Mr. C. H. Norton, authority on the subject of grinding, as a machine operation, presented an interesting statement of the state of the art in a discussion before the Master Mechanics' Association. His remarks are given below. We take pleasure in presenting them because of an error which occurred in reporting them in connection with the discussion at the convention:

"The improvements in grinding wheels within the last two years have been very marked, and what three years ago was called a good grinding wheel would not now be considered worth very much for cylindrical grinding. Perhaps it is due to the discovery of different abrasives and different methods of combining them together in wheels that has made it possible to make use of heavier grinding machines, and with them to do commercial grinding.

"As you may know, there are a number of artificial abrasives made at this time that were not known three or four years ago. For instance, artificial corundum, known as Alundum, is now made at Niagara Falls that has the same chemical properties as nature's corundum. That is, microscopic crystals of the ruby and sapphire are chemically the same as the

jewels. It seems a little funny to think of rubies and sapphires being made by the carload, but this is true. They are shipped to Worcester, where they are crushed into grains, and when their treatment is complete we have practically the pure crystals.

"The grinding machine of to-day is a very heavy machine, with plenty of pig iron in it, and very heavy steel spindles. Where four years ago a grinding machine that carried a wheel 12 ins. or 14 ins. in diameter had a spindle weighing perhaps 30 lbs. by itself, to-day a machine for doing the same work has a spindle weighing 100 lbs., a wheel 24 ins. in diameter, 2, 3 and 4 ins. thick, according to the nature of the work to be done.

"We are grinding piston rods to-day with wheels 4 ins. thick and advance along the work 4 ins. to every revolution of the rod during the roughing operation.

"Some idea of the size to which grinding machines are carried to-day may be had when I tell you that we are shipping at this time some grinding machines that are 22 ft. long and weigh some 22,000 lbs. each, and they are to grind work weighing up to 6,000 lbs. revolving on the centers of the machine.

"Briefly, the idea of the grinding machine to-day is to put more money and material into the machine, also more power into the shortest space of time to save labor."

MASTER MECHANICS' ASSOCIATION SCHOLARSHIPS.

A vacancy in the scholarship at Stevens' Institute of Technology at Hoboken should be filled immediately. The entrance examinations will be held September 14 to 17, inclusive. Anyone in the employ of members of the association is eligible and may apply to Mr. J. W. Taylor, secretary of the association, 667 The Rookery, Chicago, Ill., for further information. The J. T. Ryerson scholarship, presented at the recent convention, will be confined to Purdue University, the examinations being held September 7. This scholarship also is available to anyone in the employ of members of the association. Certificates and other information may be had from Mr. J. W. Taylor at the address already given.

The Grafstrom memorial fund is progressing and a generous response is assured from all who knew Mr. Grafstrom and those who did not, but who admire his character as shown in his self-sacrificing death. The executive committee of the Railway Supply Men, acting with the consent of the executive committee of the Master Mechanics' Association, has issued a statement of the object and plan. A quick and generous response is assured.

A new engineering association, called the American Railway Mechanical and Electrical Association, has recently been formed by the mechanical officials of electric railways. It is closely related to in object and will meet with the American Street Railway Association at Saratoga next week.

COMMUNICATIONS.

MEETING PLACE FOR CONVENTION OF 1904.

To the Editor:

I notice in your issue of August your remarks in regard to the next meeting of the Master Mechanics' Association to be held at St. Louis. You probably know that St. Louis has been mentioned before in connection with this matter, but was not considered favorably by the members of the association. One convention has been held there, which I attended, and, with many other old members, determined that I would never agree to another meeting in that city. The hotel accommodations were guaranteed, as they are now, and were found to be very unsatisfactory. The feeling toward the members of the convention was anything but genial. The citizens all seemed to be suffering from a severe frost. I earnestly hope that all the members who were with me at that time will aid in a vigorous protest against holding the convention in that city.

James M. Boon.

Chicago, August 7, 1903.

PERSONALS.

Mr. S. B. Wight has been appointed purchasing agent of the Michigan Central to succeed Mr. James R. Dutton, resigned.

Mr. A. Harrity has been appointed master mechanic of the Atchison, Topeka & Santa Fe, at Raton, New Mexico, to succeed Mr. D. A. Sullier, resigned.

Mr. A. L. Humphrey has resigned as superintendent of motive power of the Chicago & Alton to become manager of the Westinghouse Air Brake Company's interests in Chicago.

Mr. G. A. Bruce has been transferred from the position of master mechanic of the Willmar & Sioux Falls division of the Great Northern to a similar position on the Superior & Mesabi division at Superior, Wis.

Mr. A. G. Elvin has resigned as master mechanic of the Delaware, Lackawanna & Western to become manager of the mechanical department of the Coffin-Megeath Supply Company, with headquarters at Franklin, Pa.

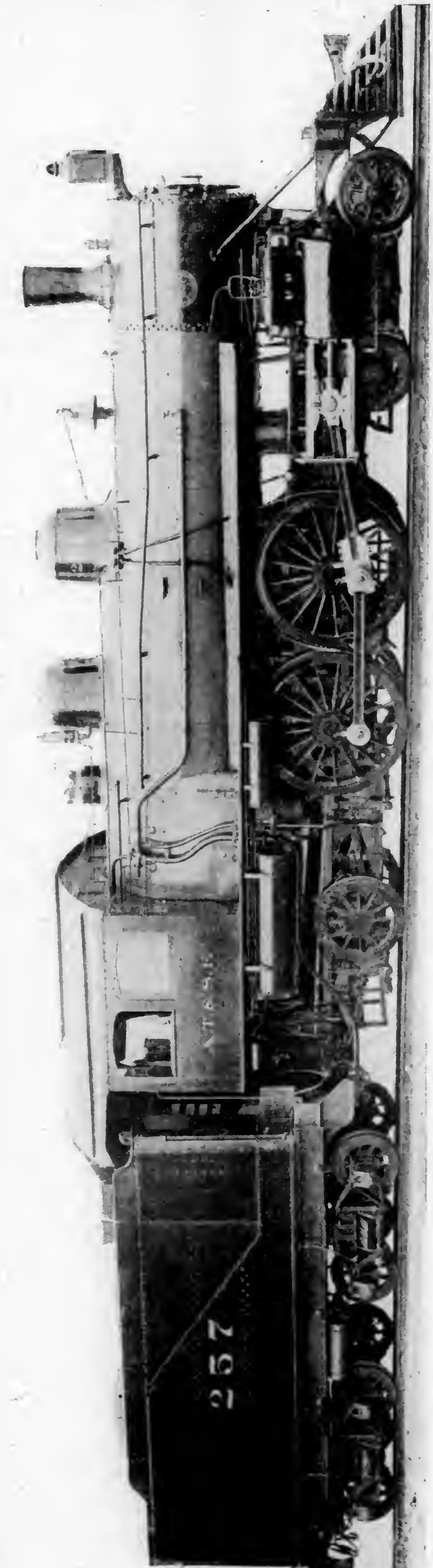
Mr. D. M. Perrine has been transferred from the position of master mechanic of the Pennsylvania at Pittsburgh to the same position at Philadelphia, and is succeeded at Pittsburgh by Mr. I. B. Thomas, promoted from the position of assistant engineer of motive power at Altoona.

Mr. R. F. Kilpatrick has been transferred from Kingsland, N. J., to Scranton, Pa., as master mechanic of the Delaware, Lackawanna & Western, to succeed Mr. A. G. Elvin, who recently resigned to enter the service of the Coffin-Megeath Supply Company. Mr. Kilpatrick is succeeded at Kingsland by Mr. W. L. Boler.

Mr. A. L. Moler has been appointed superintendent of motive power of the Chicago, Cincinnati & Louisville, with headquarters at Richmond, Ind. He has been master mechanic of the Vicksburg, Shreveport & Pacific, and is succeeded in that position by Mr. L. B. Ferguson, chief draughtsman of the New Orleans & Northeastern at Meridian, Miss.

Mr. D. F. Crawford has been appointed general superintendent of motive power of the Pennsylvania lines west of Pittsburgh, with headquarters at Pittsburgh. He is succeeded as superintendent of motive power of the Northwest System by Mr. T. W. Demarest, with headquarters at Fort Wayne, Ind. Mr. M. Dunn succeeds Mr. Demarest as superintendent of motive power of the Southwest System at Columbus. Mr. S. W. Miller succeeds Mr. Dunn as master mechanic of the shops at Columbus, and Mr. G. C. Bishop succeeds Mr. Miller as master mechanic at Logansport, Ind.

Mr. Theodore H. Curtis has been appointed superintendent of machinery of the Louisville & Nashville to succeed the late Pulaski Leeds. Mr. Curtis has been connected with this road as mechanical engineer since January 1, 1901. His railroad service began with the position of chief draughtsman of the Cleveland, Cincinnati, Chicago & St. Louis in 1886. After two years service with the Brooks and the Pittsburgh locomotive works he went to the "Nickel Plate" as chief draughtsman, and in 1899 was appointed mechanical engineer of the Erie, which position he held until he went to the Louisville & Nashville. Mr. Curtis is 37 years of age, and his appointment adds another to the list of young technical men to be selected for important motive power responsibilities. Mr. Harry Swoyer, heretofore general master mechanic, has been appointed assistant superintendent of machinery.



VAUCLAIN FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

BALDWIN LOCOMOTIVE WORKS, *Builders.*

COMPOUND PASSENGER LOCOMOTIVES, 4—4—2 TYPE

VAUCLAIN FOUR-CYLINDER BALANCED SYSTEM.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

The engraving presented at the left represents one of the four balanced compound locomotives that the Baldwin Locomotive Works have recently built for the Santa Fe. The details of these locomotives were illustrated and described very fully on pages 210-213 of our June (1903) issue, but a photograph of the locomotive was not available at that time.

These locomotives are of the 4—4—2, or Atlantic, type, but present a marked difference in external appearance, in that the main drivers are located ahead instead of at the rear, as is usual with unbalanced locomotives of this type. This construction is, of course, essential in the four-cylinder balanced compound to admit of the necessary inside rod connections between the high-pressure cylinders and the cranked main axle. Otherwise the locomotive does not differ in appearance noticeably from the ordinary 4—4—2 type engine. The results to be met in service with these engines will be eagerly watched for by all locomotive officials.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

X.

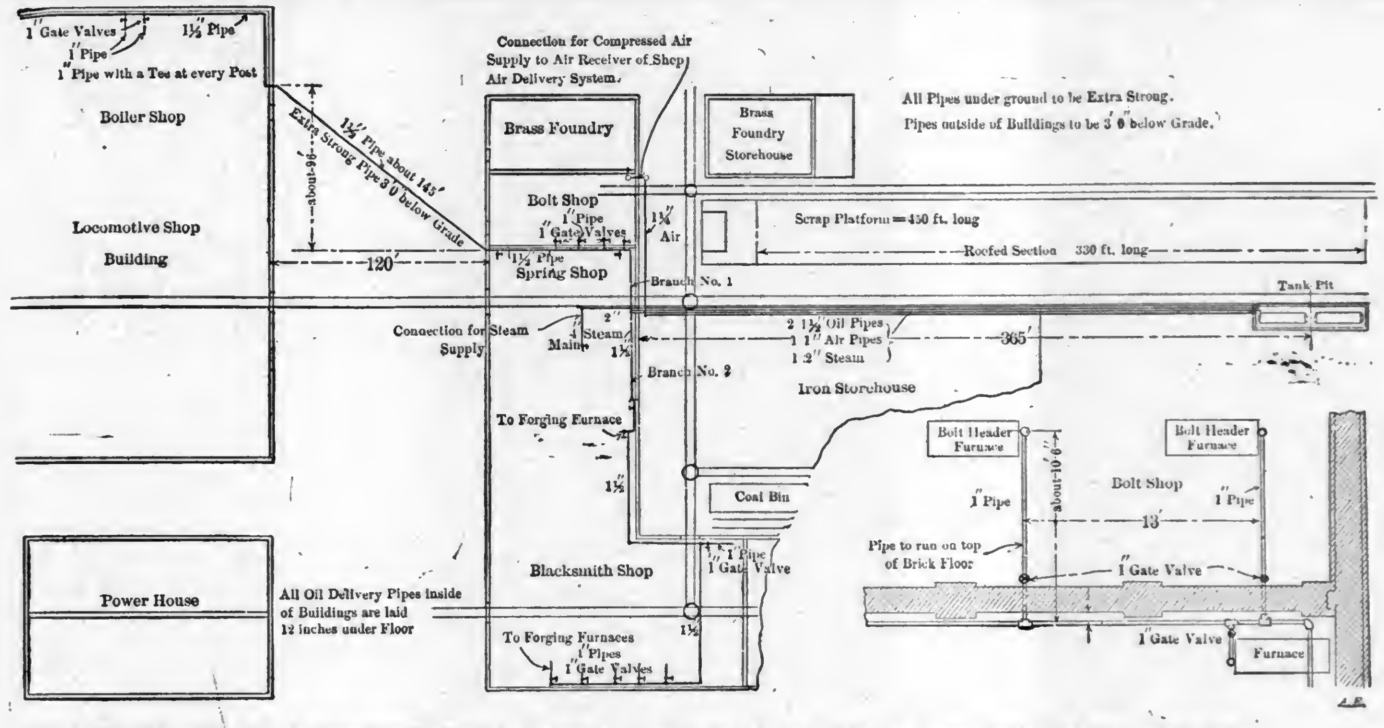
THE FUEL OIL STORAGE AND DELIVERY SYSTEM.—THE OIL FURNACES.

In the design of the auxiliary equipment for the Collinwood shops of the Lake Shore & Michigan Southern Railway particular attention was given to the arrangement of the piping and storage system for handling the fuel oil for use in the oil furnaces, as well as also to the selection of the oil furnaces for the peculiar service to be met. For a large number of the heating furnaces, as well as annealing and case-hardening furnaces, it was decided to use crude petroleum for fuel. Twenty-one oil furnaces have been placed in the boiler and blacksmith shops, which necessitated the installation of an extensive fuel supply system. The storage system adopted was that of underground storage tanks located apart from the shop buildings, from which the oil is delivered to the various furnaces by air pressure in the tanks.

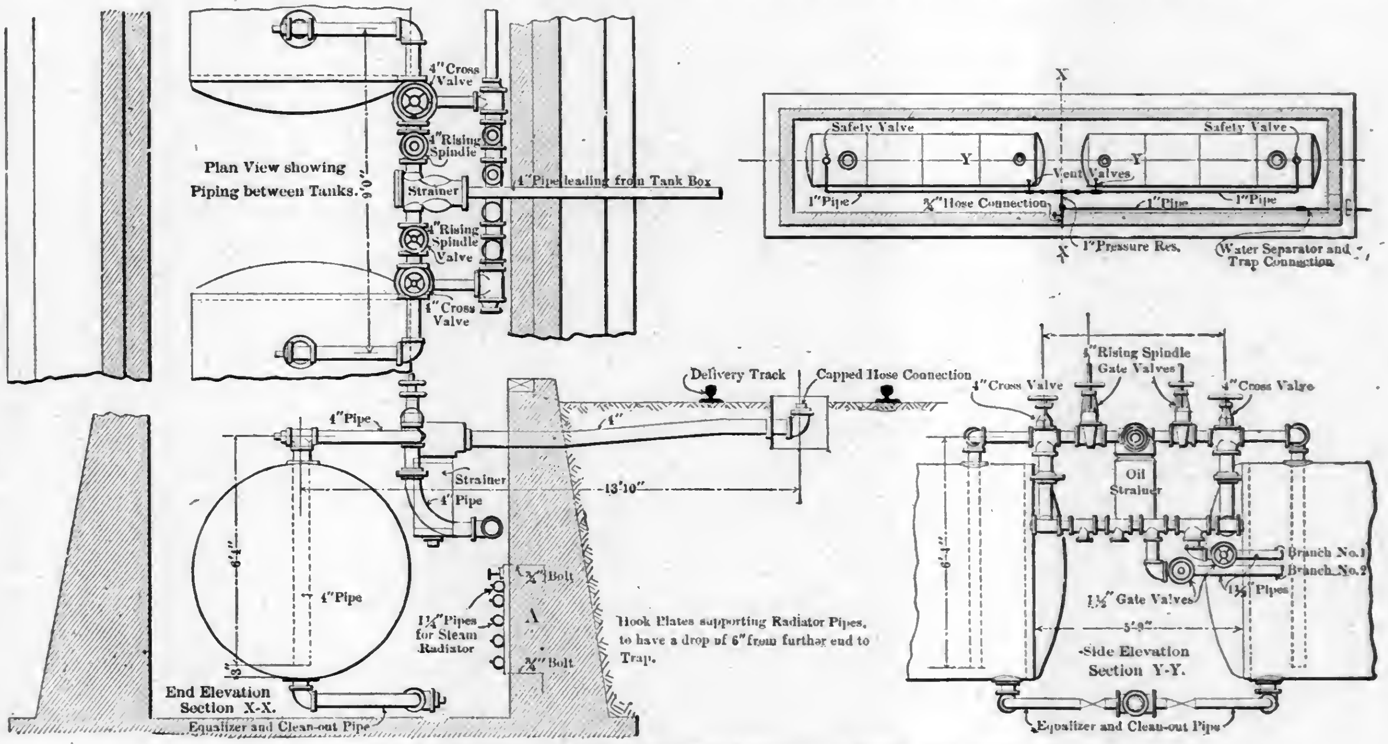
An engraving on page 335 presents a general plan of the storage tank arrangement and of the delivery piping system. The two storage tanks are situated in a depressed concrete pit, near the east end of the scrap platform, 365 ft. from the east wall of the spring shop. From this point two oil pipes run west into the blacksmith shop, where one branch (No. 2) runs south to supply the forging and case-hardening furnaces in that department, while the other (No. 1) runs north to the spring and bolt shops and thence to the boiler shop. All the piping laid underground is extra strong pipe and is placed 3 ft. below grade, except inside of buildings, where it is laid 12 ins. below the floor level.

There are two storage tanks having a capacity of 12,000 gals. Their arrangement in the pit and also the arrangement of the piping connections for filling and delivery are shown in the lower drawing. The pit is situated alongside of a track to permit filling direct from the cars, a hose connection for use with the tank cars being arranged in the special track box shown in the engraving. In filling the oil passes through the 4-in. pipe from the track and through a large strainer, from which it can be delivered into either tank. By means of the valves and connections provided, one tank may still be kept delivering oil while the other is being filled.

The tank pit is arranged for steam heating in order to increase the fluidity of the oil, the location of the radiator being indicated in the end view of the pit. Steam is piped from



PLAN OF THE FUEL OIL DELIVERY-PIPE SYSTEM, SHOWING ALSO DETAILS OF FURNACE CONNECTIONS IN THE BOLT SHOP.



DETAILS OF PIPING CONNECTIONS TO STORAGE TANKS IN THE TANK PIT.

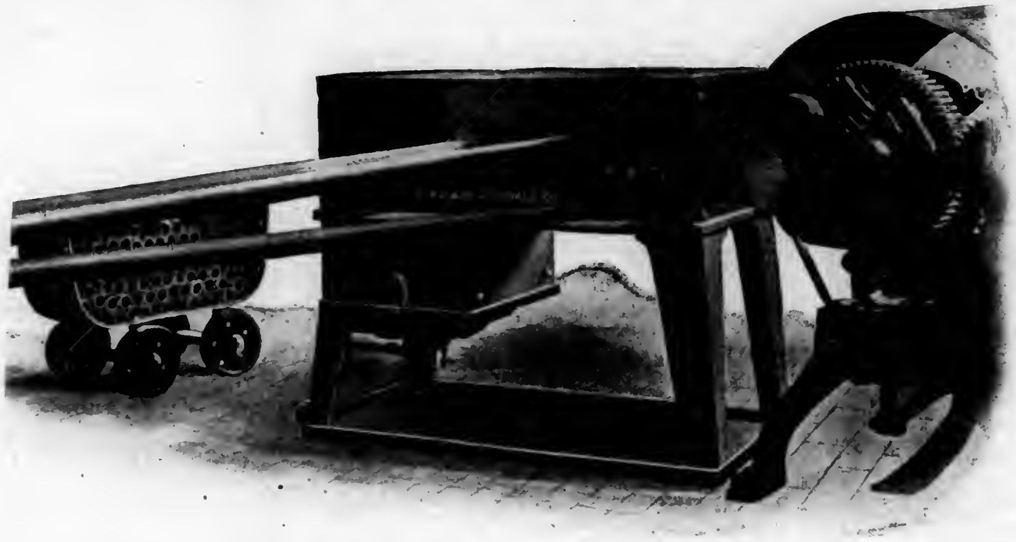
FUEL OIL STORAGE AND DELIVERY SYSTEM.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

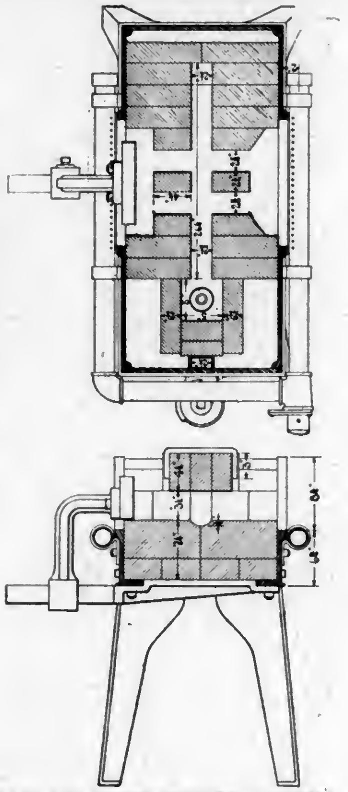
the large main supplying the steam hammers in the blacksmith shop and runs to the tank pit alongside of the oil delivery pipes, tending thus to keep the oil heated in delivery. A steam trap removes condensation from the radiator as it accumulates in heating.

The oil is forced to delivery by air pressure carried in the storage tanks. The compressed air supply is taken from one of the receivers in the shop air supply system, located in one corner of the bolt shop. The air pressure connections to the tanks are so arranged that either tank may be cut out and relieved for filling or cleaning and the other left on delivery. Either tank is safe under a pressure of 50 lbs. per square inch and each has a large pop safety valve for relieving an excess of pressure.

By means of this system of fuel supply no oil is stored at the furnaces, only the oil and air delivery pipes appearing above the floor near any of the furnaces. And furthermore each separate group of furnaces has an independent air supply, furnished by a motor-driven pressure-blower outfit, as the Ferguson furnaces which are used require a blast of about 8 ozs. pressure. There are seven blower outfits, distributed as follows: One each for the bulldozers, scrap forging, the spring shop, the bolt shop, the boiler shop, the flue and tin shop and the case-hardening furnace. The latter furnace is supplied exclusively by a single blower outfit, using a positive blower and a multiple-voltage motor so that it can be run all night at a low blast. The advantage of operating independent blower outfits lies in the fact that, while not only the cheapest and most convenient arrangement, it avoids running one large blower all the time at a low efficiency, unless all



VIEW OF THE FLUE WELDING FURNACE IN PLACE.
THE OIL FURNACES.—COLLINWOOD SHOPS.



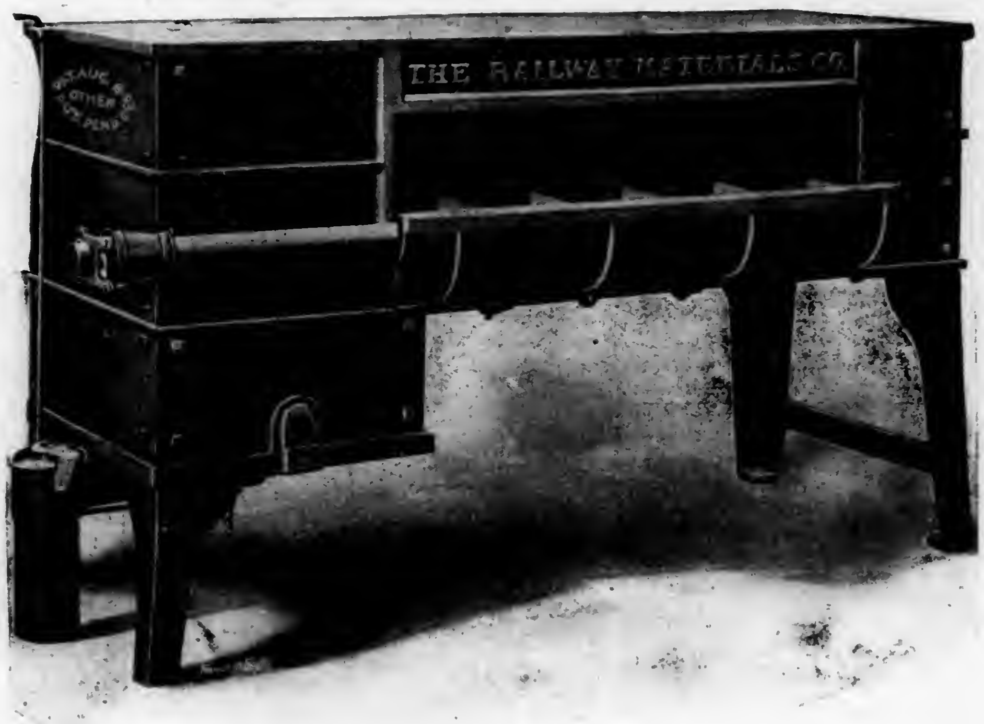
PLAN AND CROSS SECTIONAL VIEWS.

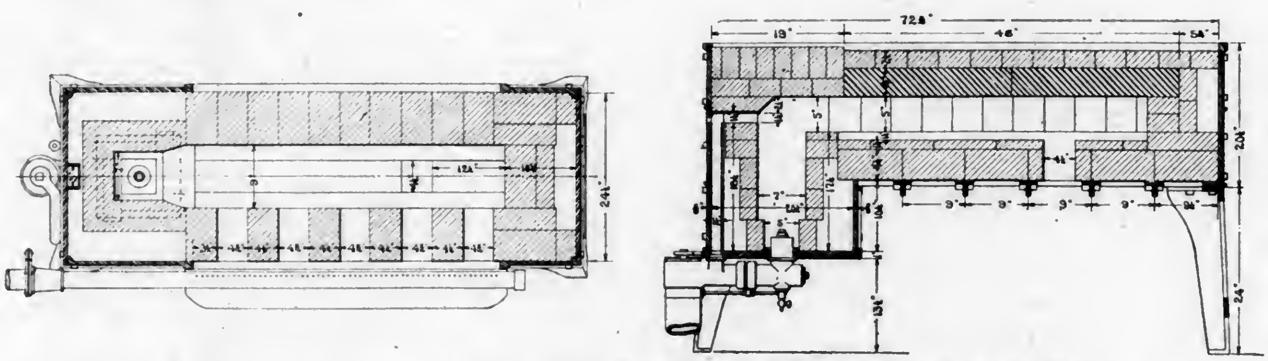
the furnaces are in use. Also it would have been very difficult to avoid large drops of pressure if a single blower and large delivery system had been used; as it was, great care had to be exercised in the designs of the various small blower systems to avoid reducing the velocities of flow of the blast by sharp elbows or abrupt turns.

Oil furnaces for flue and general blacksmith and boiler shop use offer many advantages over those using other fuel. When first introduced oil was so cheap as to cause the question of economical consumption to be overlooked; the result was a lot of home-made furnaces which, while operating satisfactorily, consume from 60 to 120 gals. of oil in doing work for which 30 to 35 gals. would be sufficient under correct furnace conditions. The time has come for the careful study of oil furnaces which has been given to this part of the equipment of the Collinwood shops, where a complete equipment of oil furnaces has been installed by the Railway Materials Company, of Chicago, under the personal direction of Mr. G. L. Bourne, of that company. These are the Ferguson furnaces, the theory of the burner of which was outlined on page 363 of the December number of this journal of last year.

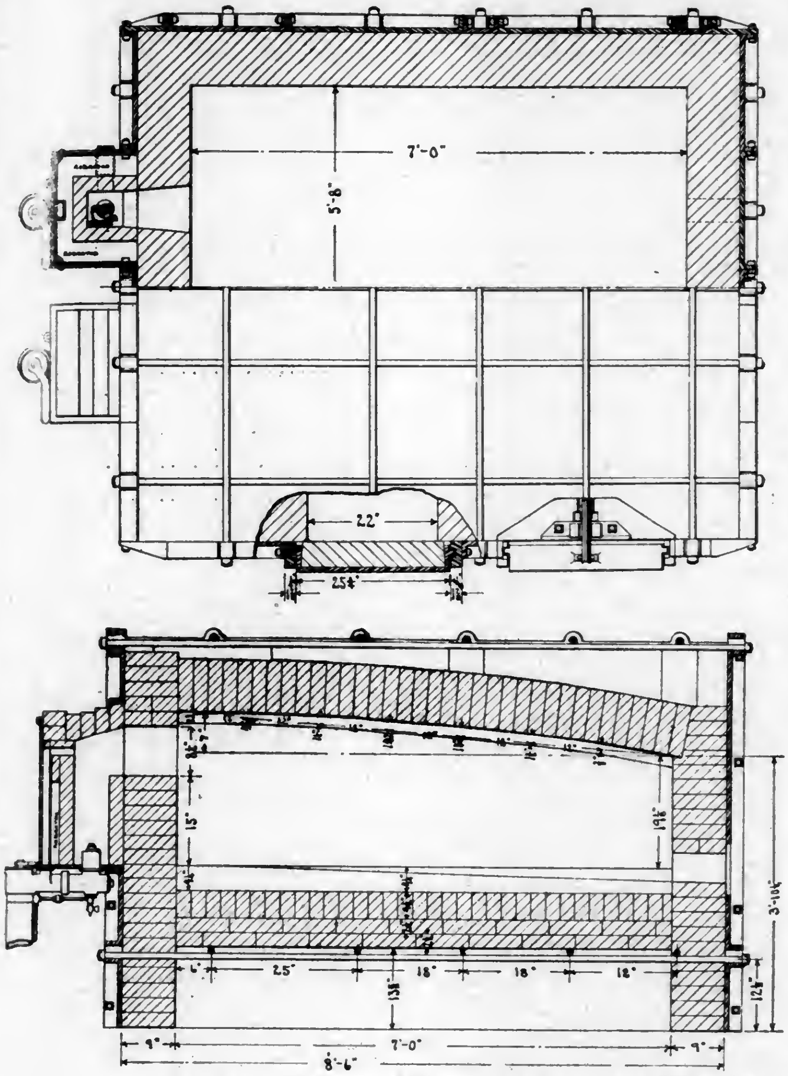
The list of this equipment at Collinwood is as follows:

Bolt shop:
  5 Bolt furnaces.





VIEW AND SECTIONAL PLAN AND ELEVATION OF THE MEDIUM-SIZED FORGING FURNACE.
THE OIL FURNACES.—COLLINWOOD SHOPS.



PLAN AND SECTIONAL ELEVATION OF THE LARGE FORGING FURNACE.

this equipment is worthy of record as an example of excellent practice, not only in the furnaces, but their installation and in the oil storage and distribution system.

In large furnaces usual practice employs brick construction with heavy buckstays to hold the structure together, and usually the door casting completes the metal parts. If an oil furnace of this kind is changed to burn coal, very little of the original investment remains. The Ferguson built up furnaces are in two parts, the brick furnace, or the lining, and the outer casing of cast iron, which is independent of the lining and put up in panels for easy enlargement or conversion for coal burning.

The flue welding furnace is illustrated on page 336. Its capacity is limited only by the ability of the attendant in handling the flues. The chief advantage offered by oil in this connection, in addition to the uniform and satisfactory high temperature, is the steadiness with which it is maintained and the saving of time lost in building and frequently cleaning a coke fire. Three of these furnaces are employed at Collinwood for flue welding, safe-ending and annealing.

Below, on page 336, the medium-sized forging furnace is illustrated. Two of these are used in the blacksmith shop, one for serving the heavy upsetting machine and the other for the Bradley hammer. One of them is bricked up to hold two crucibles for melting babbitt and the other is arranged to receive injector and other pipes for bending. They may be used from both sides or long material may be run directly through the furnaces. They are very efficient for either end or center heats.

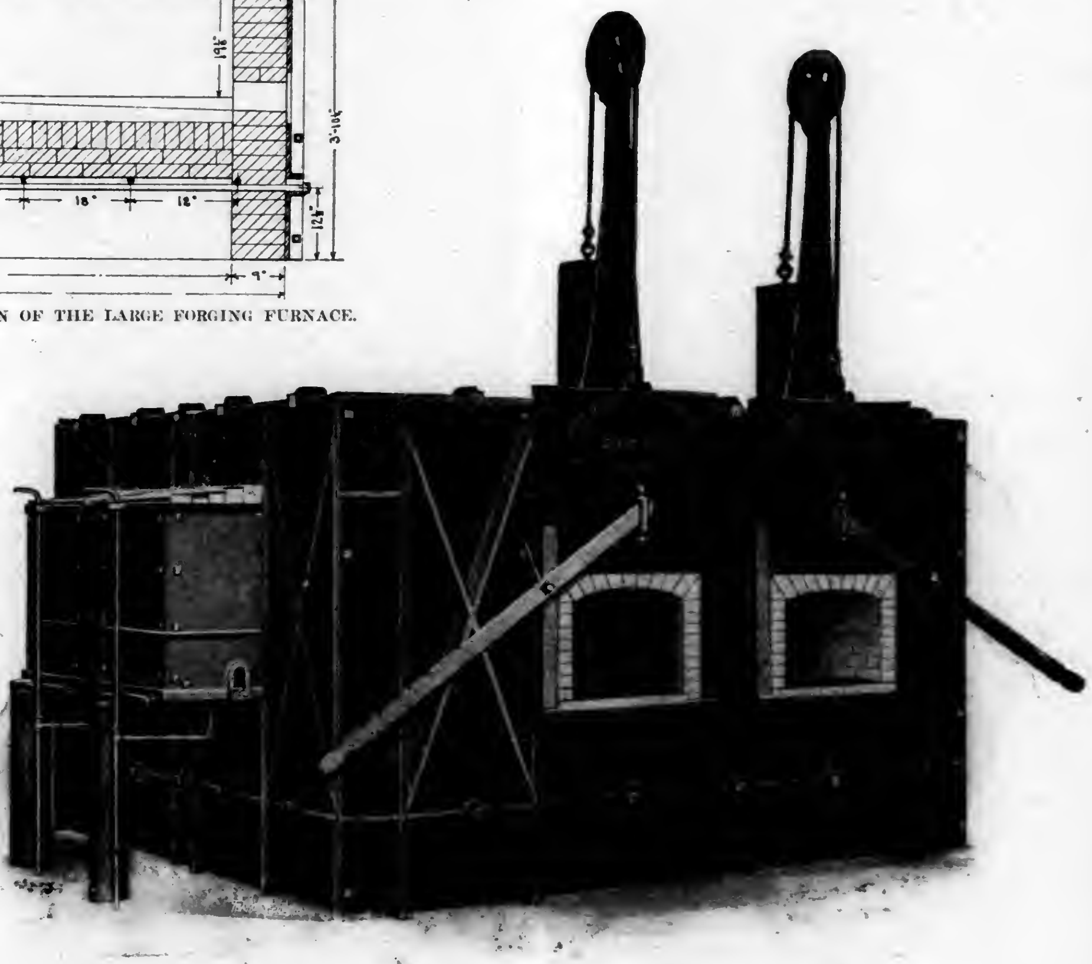
Spring shop:
- 1 Fitting furnace.
- 1 Spring tapering furnace.
- 1 Banding furnace.

Blacksmith shop:
- 2 Forging furnaces (for heavy work).
- 2 Forging furnaces (for bulldozer work).
- 1 Large bolt furnace (for bolt header).

Boiler shop:
- 3 Flue furnaces.
- 1 Flanging furnace.
- 1 Rivet furnace.
- 1 Annealing furnace.

Tin shop:
- 1 Pipe furnace.
- 1 Pipe and brazing furnace.

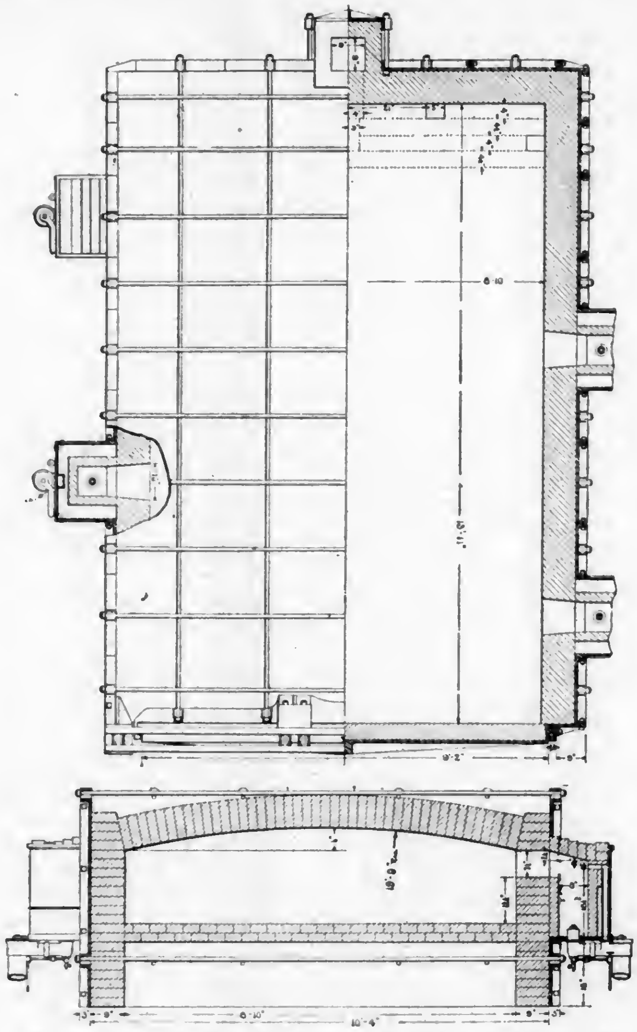
Total—21 furnaces.



THE LARGE FORGING FURNACE, SERVING THE HEAVY HAMMER IN THE SMITH SHOP.

This equipment is designed on the basis of heating all the material which the attendants can handle and the machines can use. In the case of the flue furnace, 60 flues per hour are heated to a welding heat all day long on a daily consumption of 25 gals. of oil. The bolt furnace heats the material fast enough to turn out 4,500 1-in. bolts per day on a consumption of 30 gals. of oil. Some of the large furnaces at Collinwood were specially designed for the installation, and altogether

Another design selected for illustration is the large forging furnace for serving the heavy hammer in the blacksmith shop. It is shown on this page. The object in this design was to secure the maximum heating space with the minimum floor space. No stacks or vents are provided, the whole heat being available for the material.



PLAN AND SECTIONAL ELEVATION OF THE ANNEALING AND FLANGING FURNACE.

The large annealing and flange furnace, which is shown in detail on this page, is located in the boiler shop and occupies about half the floor space required by a coal or coke furnace. This renders it possible to place the furnace favorably with reference to the work and the easy control and uniformity of the temperature undoubtedly contributes to satisfactory work and avoids the danger of flue bents and cracked sheets.

As a supplement to this description the following comparative figures are given on work by oil and coke furnaces with coke at $8.80 per ton and oil at the high price of 7.68 cents per gallon:

BOLT MACHINES.

Present furnaces use 700 lbs. of coke per day at $8.80 per ton...	$3.08
Heater per day	1.25
Machine man	1.70
Total	$6.03

Output per day per machine, 2,000 bolts; or a cost of 1,000 bolts, $3.01½.

With oil furnaces 30 U. S. gals. of oil per day used at 7.68 cents..	$2.30
Heater per day	1.25
Machine man	1.70
Total	$5.25

Output 4,000 bolts per day or cost per 1,000 bolts, $1.31.

NUT MACHINES.

Present furnaces use 1,200 lbs. coke per day at $8.80 per ton....	$5.28
Heater per day	1.30
Machine man	1.70
Total	$8.28

Output per day 2,000 lbs. nuts; cost per 1,000 lbs. of nuts, $4.14.

With oil furnace 50 U. S. gals. of oil to be consumed at 7.68 cents per gal.	$3.94
Heater per day	1.30
Machine man	1.70
Total	$6.94

Output per day 3,000 lbs. or cost per 1,000 lbs. nuts, $2.31.

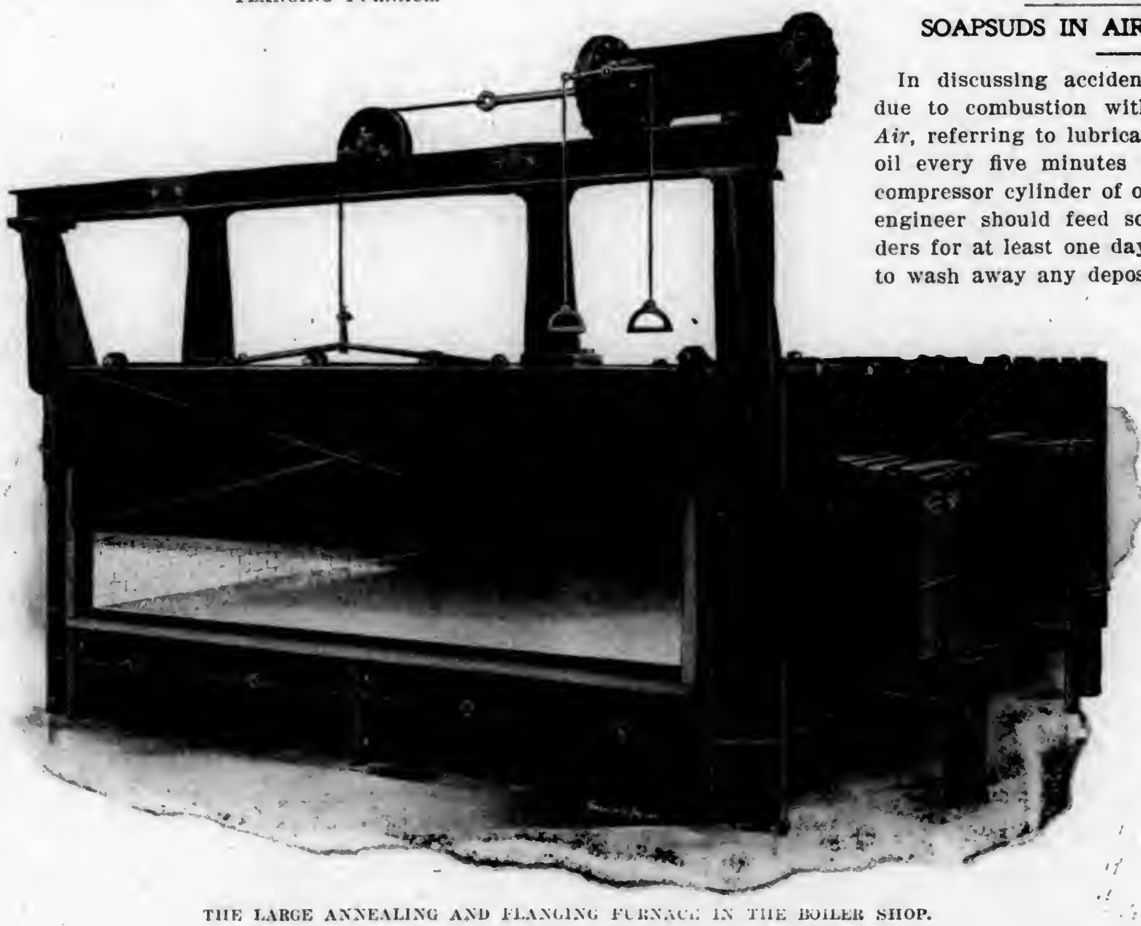
FLUE WELDER.

Present furnaces use 400 lbs. coke at $8.80 per ton	$1.70
Heater per day	1.30
Machine man	1.50
Total	$4.56

Output per day 100 flues or cost per 100 flues, $4.56.

An oil furnace uses 25 U. S. gals. of oil at 7.68 cents	$1.92
Heater, same as above	2.80
Total	$4.72

Output per day, 600 flues, or cost per 100 flues not quite 80 cents.



THE LARGE ANNEALING AND FLANGING FURNACE IN THE BOILER SHOP.

THE OIL FURNACES.—COLLINWOOD SHOPS.

SOAPSUDS IN AIR COMPRESSORS.

In discussing accidents to air compressors due to combustion within them, *Compressed Air*, referring to lubrication, says: "A drop of oil every five minutes is sufficient in an air compressor cylinder of ordinary size, and every engineer should feed soapsuds into his cylinders for at least one day in the week, in order to wash away any deposit which may have accumulated through the use of oil which has been acted on by high temperatures in the air. These soapsuds may be fed through the regular oil cup. Care should be taken, however, not to let the machine lie idle with soapsuds remaining in it—that is, shortly before quitting time the feeding of soapsuds should be stopped and oil feeding substituted." This is of importance, particularly with high pressures. It will also assist in reducing wear in cylinders.

THE SHEEDY CIRCULATING PIPE FOR LOCOMOTIVE CYLINDERS.

This device has been in use nearly two years on the Southern Pacific with satisfactory results. Its purpose will be understood through a description of its operation. When the throttle is open, steam enters the small pipe in the branch pipe at A, Fig. 2, passes through the connecting pipes and seats the valve C by means of the piston in the cylinder B. When the throttle is closed the check valve C closes and the pressure in B leaks off through a small hole in the check valve. The valves C are opened by the springs in the cylinder B and the circulating pipe is open from one end of the cylinder to the other. The action is automatic and the effect is the same as that produced by the "floating" of an ordinary slide valve when an engine is drifting. The relief valves D provide means of escape of water in the cylinders which may destroy the cylinders, break the crosshead, or bend the piston rod, of a piston valve engine. Fig. 3, on the following page, illustrates an improved arrangement of the valves.

The compression of air when drifting is greater in an engine with piston valves than in one with plain valves because of the smaller clearance spaces and the inability of the valves to lift. The compression is often a serious matter, not only because of the shocks to the machinery, but because of causing flat spots in the tires. Indicator cards do not give a measure of the shocks because much of the energy of compression is absorbed in retarding the reciprocating parts, and it is only by combining the inertia effect at the different points of the stroke with the cylinder pressure at those points that the true action of the compression can be obtained. If an indicator is used on a piston valve engine drifting at 40 or 45 miles an hour the compression will make it "pound" so that it will not record positively. This indicates that something is going on in the cylinder in the way of sudden shocks.

The indicator cards of Fig. 4 from the low pressure cylinder of engine No. 2918 illustrate the effect of the Sheedy circulating pipe. These cards were taken with and without the pipe in action and comparisons may be drawn at very nearly the same speeds. The mean of all the cards shows a relief by action of the circulating pipe of 29.4 per cent of the brake power of the pistons in descending grades. A notable condition in the Sheedy device is the absence of shock of compression at the end of the stroke and the braking effect is shown to be a steady resistance when the reverse lever is at full stroke. The advantage of the braking effect of the cylinders on

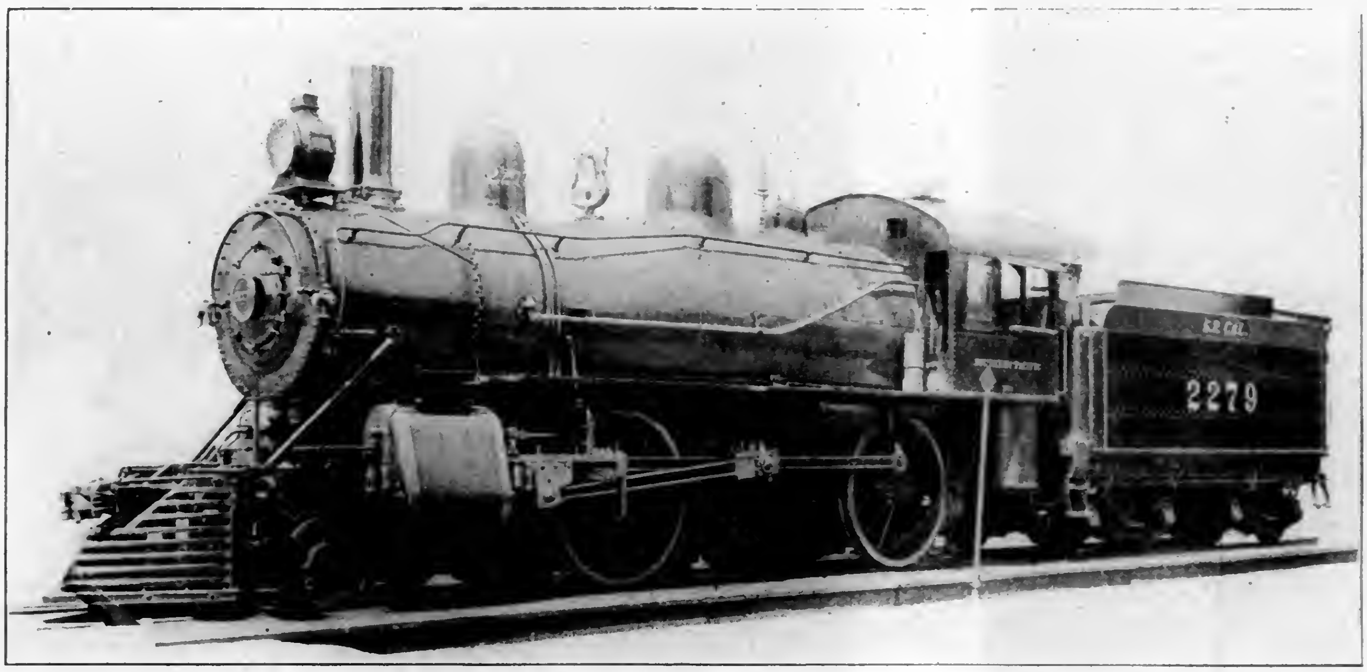


FIG. 1.—VIEW OF THE CIRCULATING PIPE APPLIED TO A SOUTHERN PACIFIC LOCOMOTIVE.

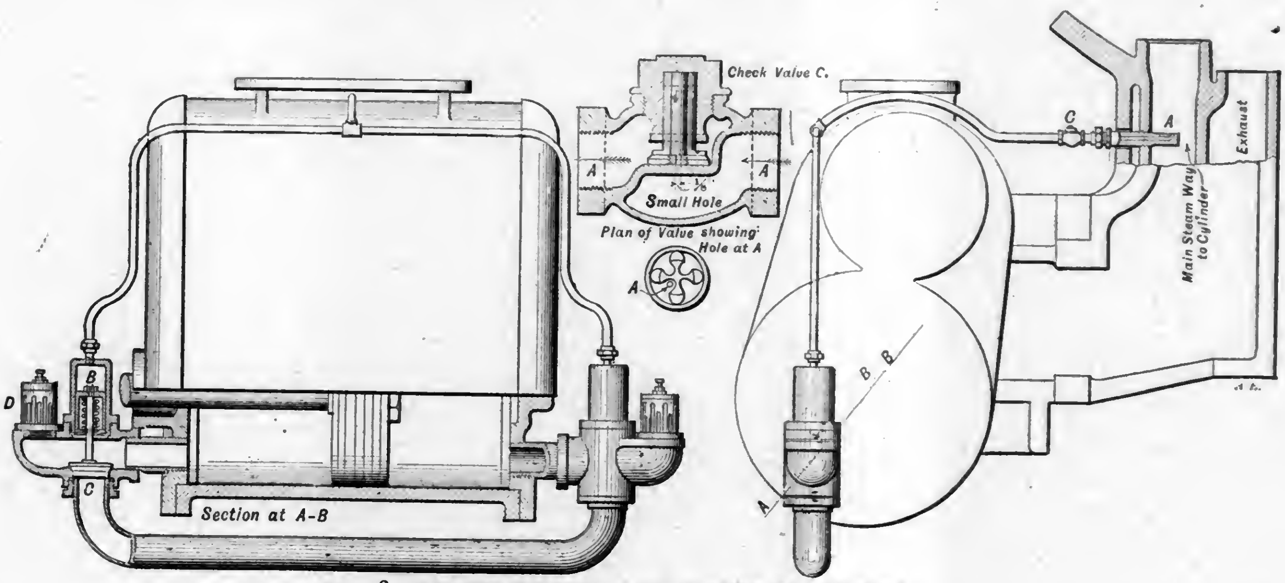
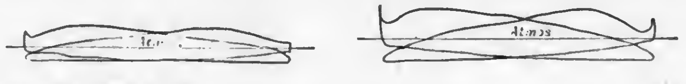
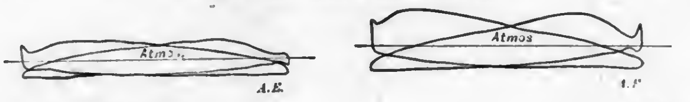


FIG. 2.—SECTION SHOWING ATTACHMENT TO CYLINDER.



27	Speed, M. P. H	28
6.0	Mean brake pressure	8.5
153.0	Total brake H. P. on piston	226.1

32.3 per cent. brake power relieved.



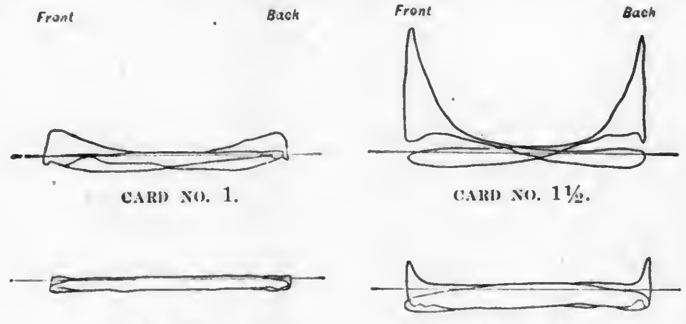
29	Speed, M. P. H	29
6.6	Mean brake pressure	9.08
179.7	Total brake H. P. on piston	247.34

27.3 per cent. brake power relieved.

FIG. 4.

descending grades is acknowledged, but it should be given without shock to the engine.

The accompanying photograph, Fig. 1, shows the application of the device to one of a number of simple piston-valve engines upon this road. The indicator cards, Fig. 5, from this engine illustrate the effect of the circulator. This engine was taken into the shop for repairs after 18 months' service, and the piston valves were found to be in perfect order with no sign of wear. Fig. 2 shows the application of the low pressure



CARD NO. 1. CARD NO. 1½.

CARD NO. 6. CARD NO. 6½.

No. Card	1	1½	6	6½
Cut off—position of lever	10	10	22	22
Speed—M. P. H	41	41	40	42
Mean brake pressure on piston, lbs.	5.77	7.2	4.57	9.32
Total brake power—H. P.	100	126	80	170
Per cent. relieved by pipe	21	..	52	..
Terminal compression above atmosphere	10	60	2	15
Per cent. relieved by pipe	80	..	86	..

STEAM CHEST CARDS WITH PIPE CUT OUT—SHOWING PRESSURE IN STEAM CHEST WITH THESE CUT-OFFS.

FIG. 5.

cylinder of the compound engine No. 2474. Mr. Small sums up the advantages as follows:

The device is absolutely automatic, the valves are bound to close when the throttle is opened and are sure to open when it is closed. Its application to a simple engine brings the compression line just where it is wanted. In the case of engine No. 2279 it takes off 83 per cent at the point of terminal compression and leaves enough to steady the reciprocating parts when the engine is drifting at high speed. The circulator keeps the temperature of the air in the cylinders normal. It is not chilled, as in the case of valves opening to the atmosphere, and it is not heated hot enough to melt the rod packing rings and destroy the lubricating oil, which has occurred. This arrangement on either a single expansion engine or on the large cylinder of a compound engine prevents drawing gases through the exhaust nozzle to relieve vacuum, taking in cinders and destroying the lubrication and piston packing, and it also avoids the undesirable draft on the fire in drifting. With this draft the grates must be kept covered, even if the pops are blowing, in order to protect the firebox from injury. The problem of relieving cylinders from water

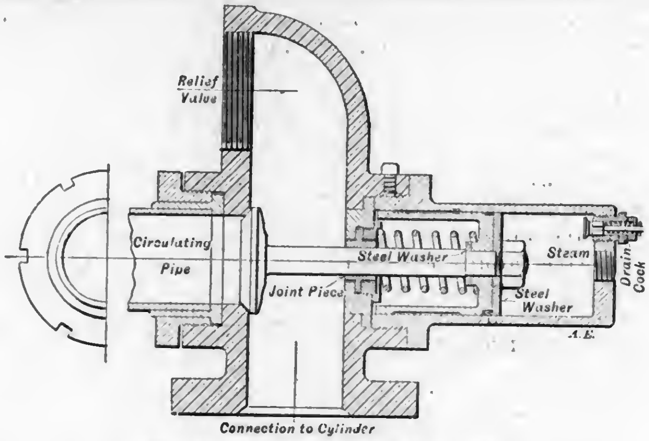


FIG. 3.—DETAILS OF RELIEF VALVE.

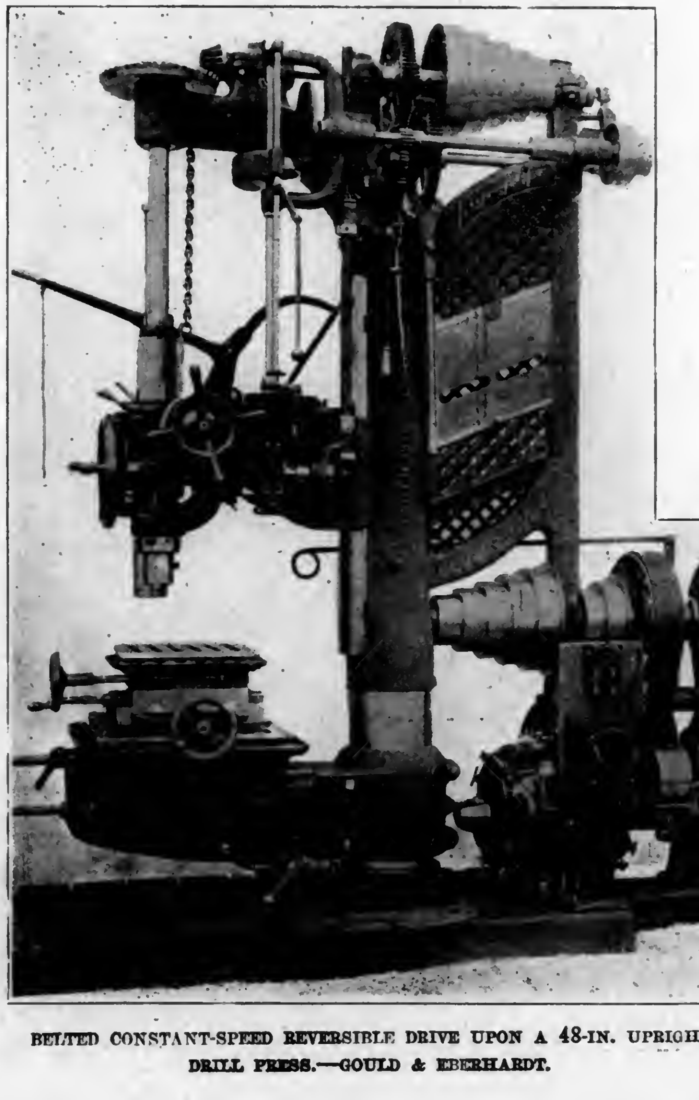
has given serious trouble on this road when the boilers are inclined to prime.

This device is protected by patent issued to Messrs. P. Sheedy and A. Campbell. The drawings and information were supplied by Mr. H. J. Small, general superintendent of motive power of the Southern Pacific Company.

MOTOR-DRIVEN MACHINE TOOLS.

RECENT PRACTICE IN THE APPLICATION OF ELECTRIC DRIVES TO DRILLING MACHINERY.

Important developments have, of late, been made in methods of applying electric-driving to drilling machinery, as well as to other classes of machine tools. The importance of having available at all times at the drill the ready and ample power supply, inherent in the motor drive, to enable the greatest



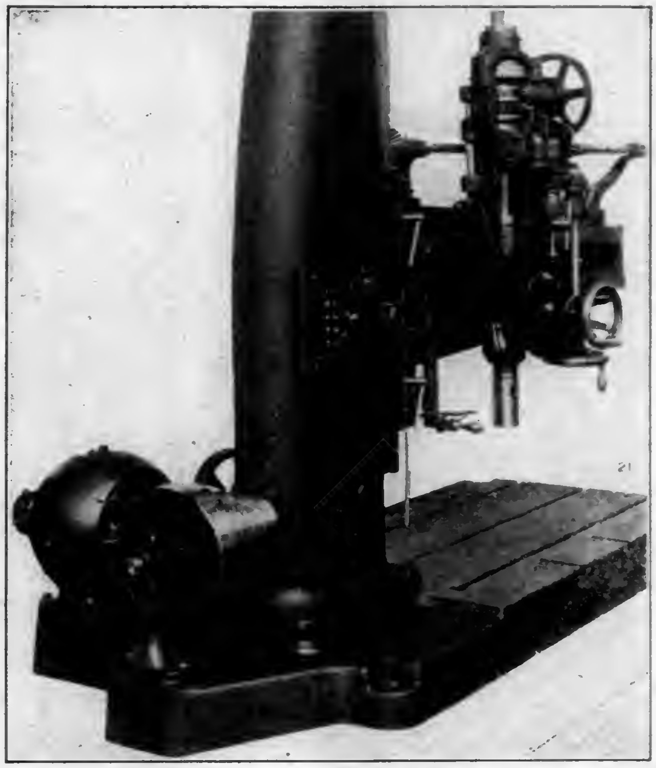
BELTED CONSTANT-SPEED REVERSIBLE DRIVE UPON A 48-IN. UPRIGHT DRILL PRESS.—GOULD & EBERHARDT.

capacity of the tool to be reached, is being comprehended by the users of machine tools as well as the builders. Electric driving has been a strong factor in rendering the greatly increased production possible with drilling machinery. We are permitted to present herewith illustrations of several representative methods of arranging motor-drives for this class of tools.

An interesting drive is presented in the engraving on page 340, which illustrates the 48-in. patent-upright drill press, with a constant-speed electric drive, which Gould & Eberhardt, Newark, N. J., recently furnished to the Norfolk Navy Yard. This tool is in itself very complete and general in its adaptability to all classes of work, having a special oblong, compound-traverse tapping table and portable compound chuck, and also an automatic tapping attachment. It is fitted with the many improvements, including automatic friction feeds and time-saving refinements, that characterize the Gould & Eberhardt drills, and also has a back brace.

The important feature of this tool is arrangement of the drive. The motor, which is an enclosed constant-speed, direct-current machine, is located under the forked brace, on an extension of the base, with the main switch and starting box located conveniently near. It drives the small countershaft above it either through a direct belt for forward motion, or through a geared pulley and direct belt for reverse motion, as is clearly shown in the engraving. Both of these belts operate with the motor, either one being thrown in action at will by the friction clutch having a handle extending out over the table. This arrangement is very commendable, as it obviates the necessity of using crossed-belts, with their attendant disadvantages, for the reverse motion. It is a very convenient method of driving with a constant-speed motor also, as the friction-clutch drive enables the drill spindle to be started and stopped instantly without waiting for the motor to come to rest.

The two engravings presented upon this page illustrate the methods of mounting both variable-speed and constant-speed drives, which have successfully been made use of by the Fosdick Machine Tool Company, Cincinnati, Ohio. These examples will take their place as the best practice in motor applications to this class of tools, the variable-speed drive being especially commendable.

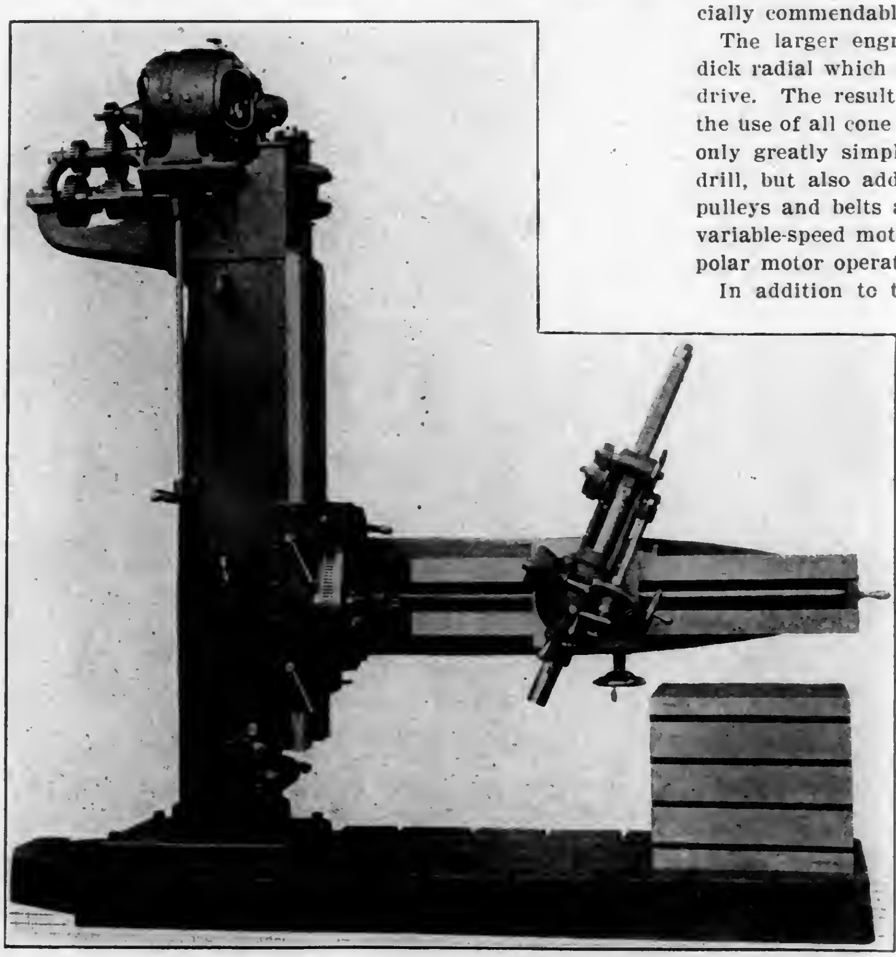


CONSTANT-SPEED DRIVE UPON A DRILL PRESS.—FOSDICK MACHINE TOOL COMPANY.

The larger engraving represents a 6-ft. full-universal Fosdick radial which has been adapted for a variable-speed motor drive. The result is an exceedingly neat drive, inasmuch as the use of all cone pulleys and belts is entirely obviated; it not only greatly simplifies the construction and operation of the drill, but also adds greatly to its general appearance. Cone pulleys and belts are rendered unnecessary by the use of the variable-speed motor, which is a 3-h.p. General Electric multipolar motor operating with field control.

In addition to the range of speeds provided in the motor two speed-changes are also obtained by means of two gear trains adjacent to the motor pinion. Either one is thrown into action by a friction clutch operated by the lever shown below on the column. The other interesting features of this universal drill are in no way interfered with, the most noticeable effect of the change being the absence of the cone pulleys and belts and the necessary accompanying supports, brackets, belt shifters, etc.

In the upper engraving is shown the method used by the Fosdick Company in applying a constant-speed drive. The machine shown is one of the 4-ft. plain Fosdick radials, which has been equipped with a 3-h.p. constant-speed, direct-current motor built by the Northern Electrical Manufacturing Company, Madison, Wis. This is a very convenient arrangement of adapting an individual drive to an existing tool without changing it greatly, as the motor may easily be mounted to drive the lower cone pulley through a conveniently arranged gear reduction. In this case the motor is mounted upon an extension of the base



DIRECT-GEARED DRIVE UPON A 6-FT. FULL UNIVERSAL RADIAL DRILL.—FOSDICK MACHINE TOOL COMPANY.
GENERAL ELECTRIC VARIABLE-SPEED MOTOR BY FIELD CONTROL.

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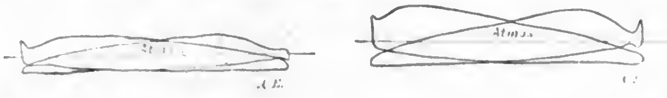

29	Speed, M. P. H.	29
6.6	Mean brake pressure	9.08
179.7	Total brake H. P. on piston	217.31

27 3 per cent. brake power relieved.

FIG. 4.

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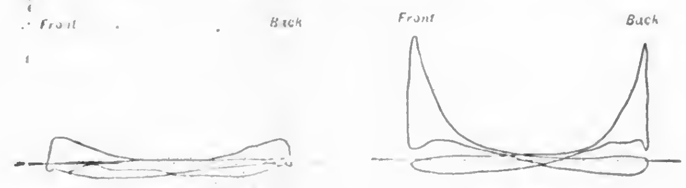

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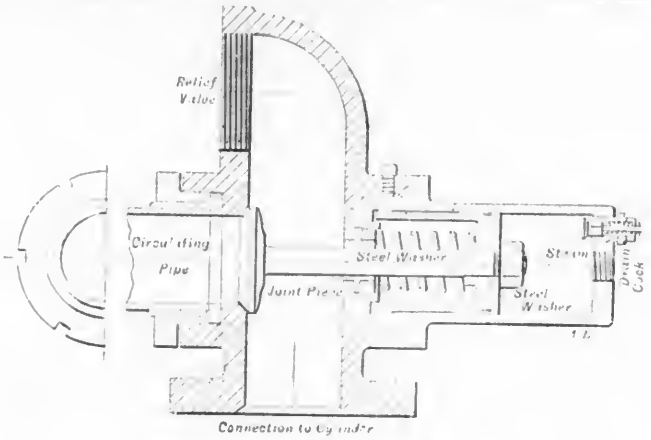

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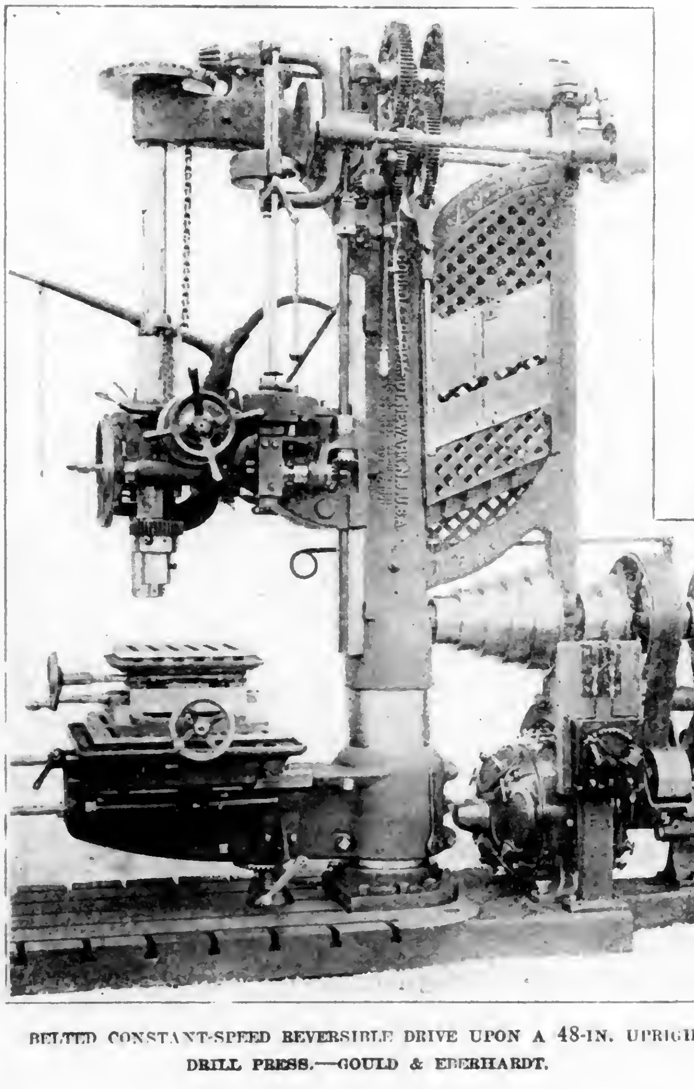

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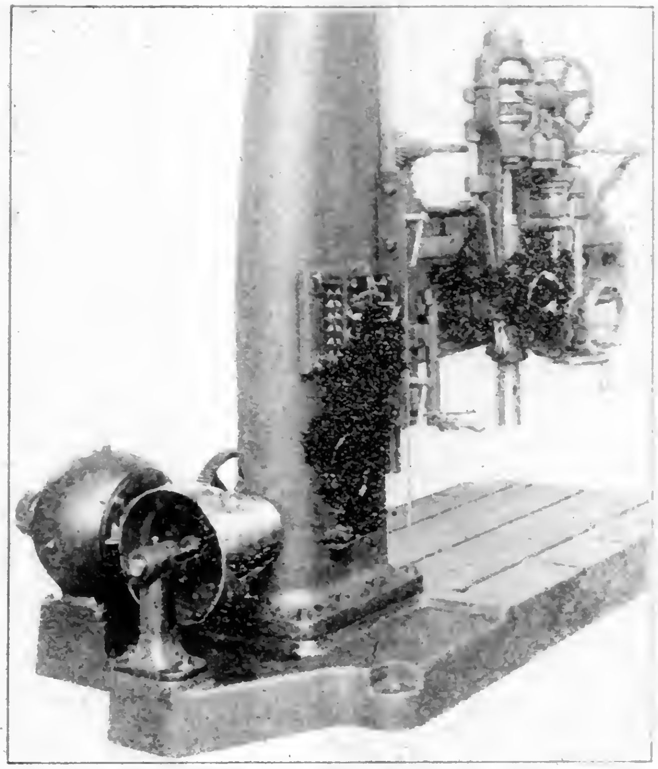

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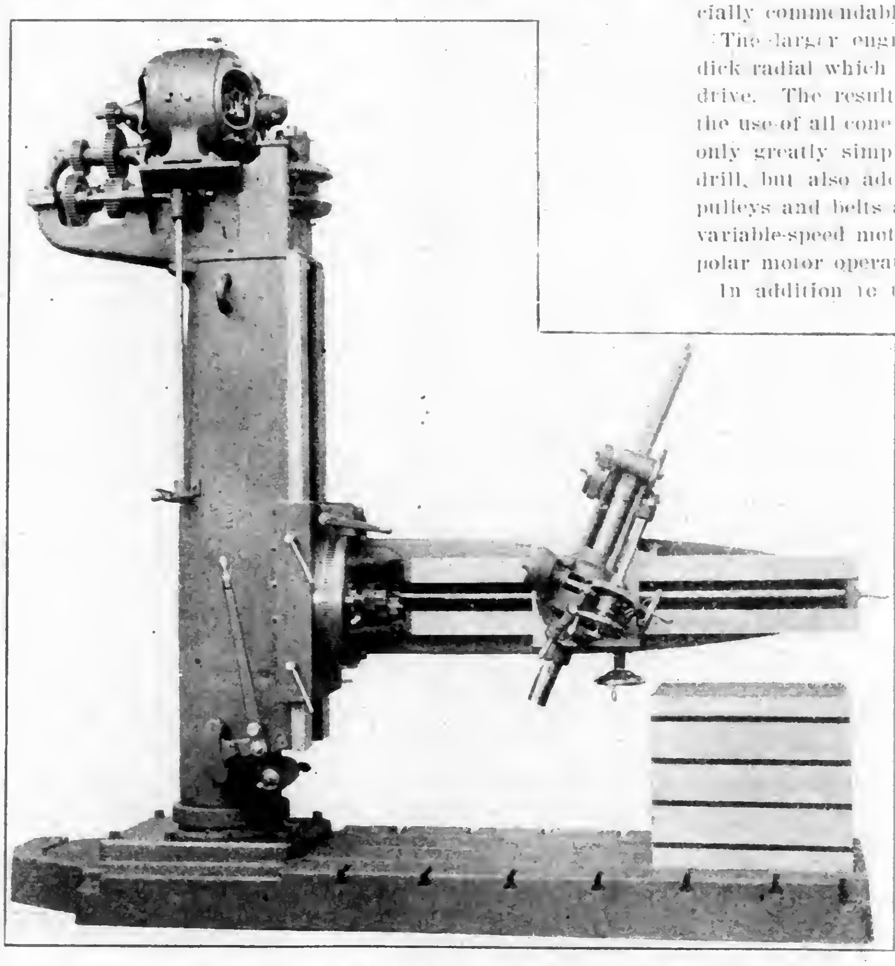

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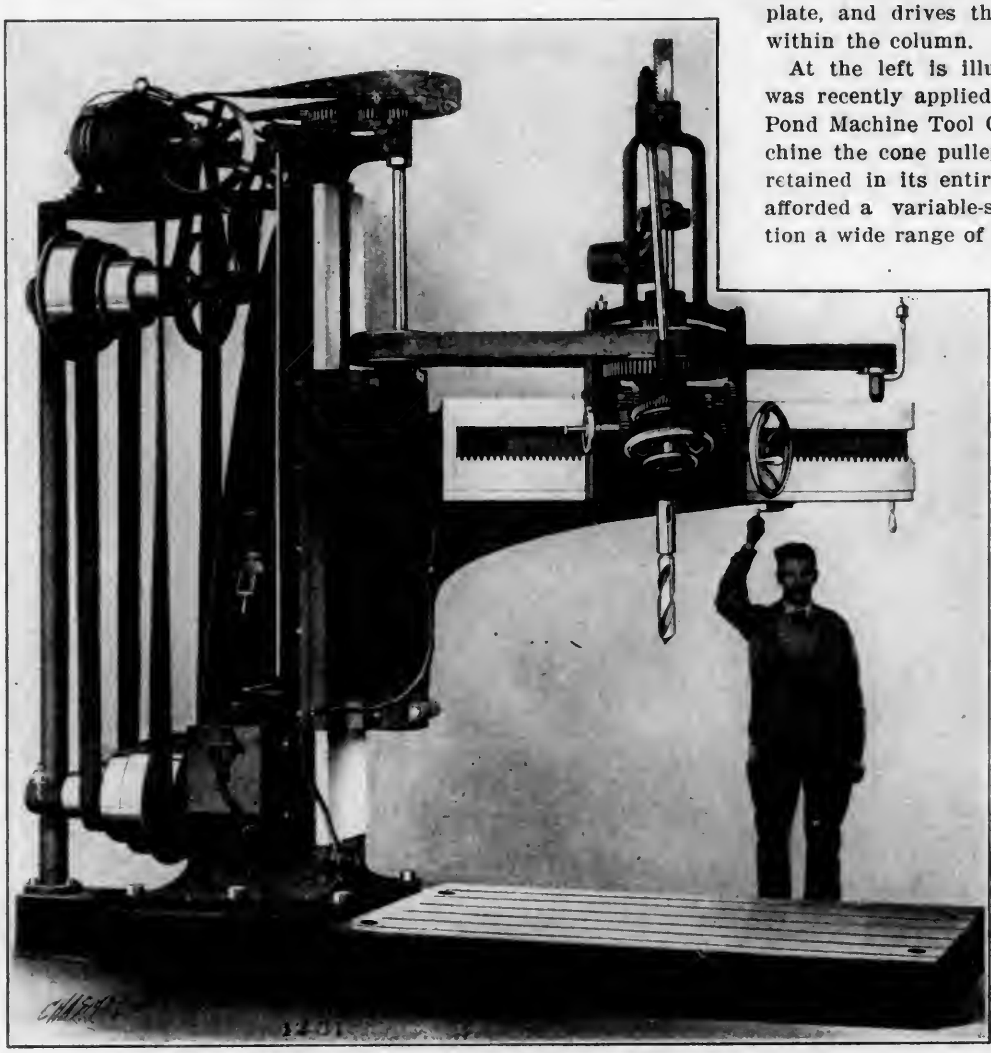
GENERAL ELECTRIC VARIABLE-SPEED MOTOR BY FIELD CONTROL.



COMBINATION CHAIN AND BELTED DRIVE UPON A 6-FT RADIAL DRILL.—POND MACHINE TOOL COMPANY.

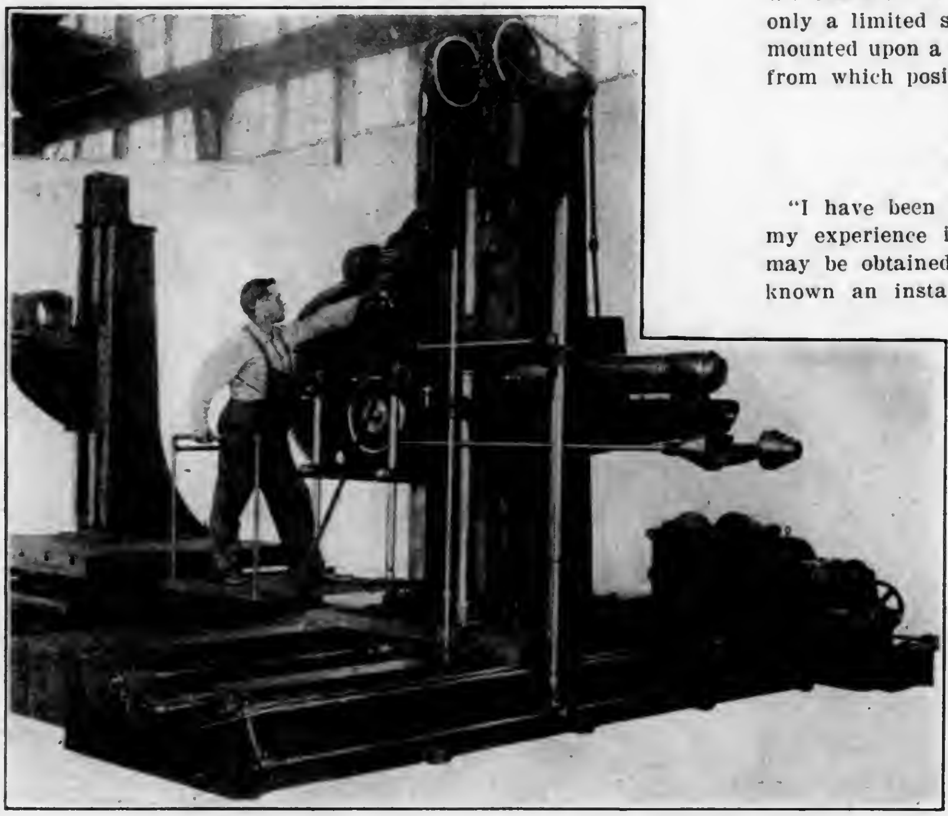
plate, and drives the lower cone shaft through bevel gears within the column.

At the left is illustrated a type of individual drive that was recently applied to a 6-ft. plain radial drill built by the Pond Machine Tool Company, Plainfield, N. J. Upon this machine the cone pulleys and standard belt drive to the arm is retained in its entirety; in addition to the speed-range thus afforded a variable-speed motor is used, from which combination a wide range of speeds are available.

The motor, which is a 3-h.p. Lundell motor at 1,000 revolutions per minute, is mounted upon a bracket above the upper cone pulley, from which it drives that cone shaft by a Renold silent chain. The balance of the drive does not differ from that on the standard radial. The speed variation is obtained by field control, the hand controller being located on the arm as shown above the man's head; a flexible cable effects the connections between the controller and resistance box located on the side of the column.

The engraving below illustrates an individual drive upon a large horizontal-spindle drilling, boring and milling machine, which indicates an excellent arrangement for applying electric driving to a large tool. This tool is the No. 5 boring machine, with 9 x 12-ft. platen, built by Beaman & Smith, Providence, R. I., one of which was thus equipped for the new shops of the United States Navy Yard at Brooklyn, N. Y. The motor is a 10-h.p. constant-speed direct-current motor, supplied by the General Electric Company.

Only a limited number of different speeds are available from belt cone and gear changes in this drive, but on account of the large size of the tool and the character of the work to be handled, it is probable that only a limited speed range would be needed. The motor is mounted upon a bracket located in place of the driving pulley, from which position it drives direct through gearing.



GEARED DRIVE UPON A LARGE HORIZONTAL DRILLING AND BORING MACHINE. —BEAMAN & SMITH.

UNDISCOVERED MERIT.

"I have been some time in this world, and the result of my experience is that there is one way by which success may be obtained with ability. In all my life I have never known an instance of undiscovered merit. There are too many seekers to allow ability to remain hid. If you possess ability and were placed in a diving bell and lowered to the bottom of the sea, expeditions would be fitted out to discover you and bring you back.

"No matter what calling you embrace, if you have ability you will be in demand. If a lawyer, think how many persons there are in trouble who would be seeking your advice. If a physician, how many there are who are ill, who would want your services. If an architect, how many who desire better houses built. I have heard it said that a young man needs a pull to get a start. Pay no attention to that. If you have ability you will win."—The Hon. W. Bourke Cockran, in an address to the graduates of Manhattan College.

THE WELLMAN-STREET STEEL CAR.

The accompanying illustration shows the general appearance of a new design of steel hopper car recently built by the Wellman-Seaver-Morgan Engineering Company, of Cleveland, Ohio, under patents issued to S. T. Wellman and Clement F. Street. This car is a radical and interesting departure from the designs in common use. The object was to reduce the number of points at which corrosion will be likely to take place, to produce a car which shall be self-clearing and also one which can be repaired at a low cost.

The center sills consist of two 15-in. channels with flanges turned toward the center. A gusset plate is riveted to the outside of each channel and extends from one center plate to the other. An angle iron is riveted to the lower edge of this gusset plate, forming a girder 27 ins. deep at the center, and extending from truck to truck. This girder is designed to have ample strength for carrying the entire load of 100,000 lbs.

It will be noted from the illustration that the side plates are curved, and that the customary form of side sill is entirely eliminated. The result of this curved form of plate is a car which will readily clear. A careful measurement shows that the lineal feet of joint exposed to load is 45 per cent. less than in the customary form of car. The manufacturers claim that as corrosion begins at these points, the life of this car will be very much longer than that of any other in use. The elimination of the customary form of side sill makes a material reduction in what the manufacturers of this car claim to be unnecessary dead weight, and this weight has been put in the plates of the car where it is believed to be more effective. These plates are 5-16 in. thick instead of ¼ inch, as in customary practice. One of the important advantages claimed is the large area of door openings. This is 56 sq. ft., while in most steel cars it is only from 20 to 25 sq. ft. This very large door opening, together with the curved form of plate employed, contribute to the clearing of the load.

The ends of the center sills of this car are tied together by a heavy steel casting, and this casting serves also for the central portion of the end sills. The ends of the end sills are formed of short pieces of 8-in. channels, securely riveted to the steel castings referred to and extending to the sides of the car. The push pole socket is riveted to these channels and also to a short 8-in. channel, which extends from the corner of the car to a heavy steel casting riveted to the side of the car close to the door opening. This construction is further stiffened by two angles extending from the corner of the car back to the body bolster near its junction with the center sills. As most of the damage to steel cars is caused by corner blows, this gives a construction which can be easily repaired. The idea is that under a corner blow the only parts receiving damage will be the channels and angles referred to. As these are commercial shapes they can be readily renewed, or if not too badly damaged they may be straightened and replaced.

This car was placed on exhibition at the recent convention of the Master Car Builders' Association, and created a great deal of interest among the railroad officers. The criticisms indicated a general feeling that this car presents valuable features and that its success is assured. The sample car has gone into exceedingly severe service, where its merits will be effectually tested. Further information may be had from Mr. Clement F. Street, manager of the railway department of the Wellman-Seaver-Morgan Engineering Company, Cleveland, Ohio.

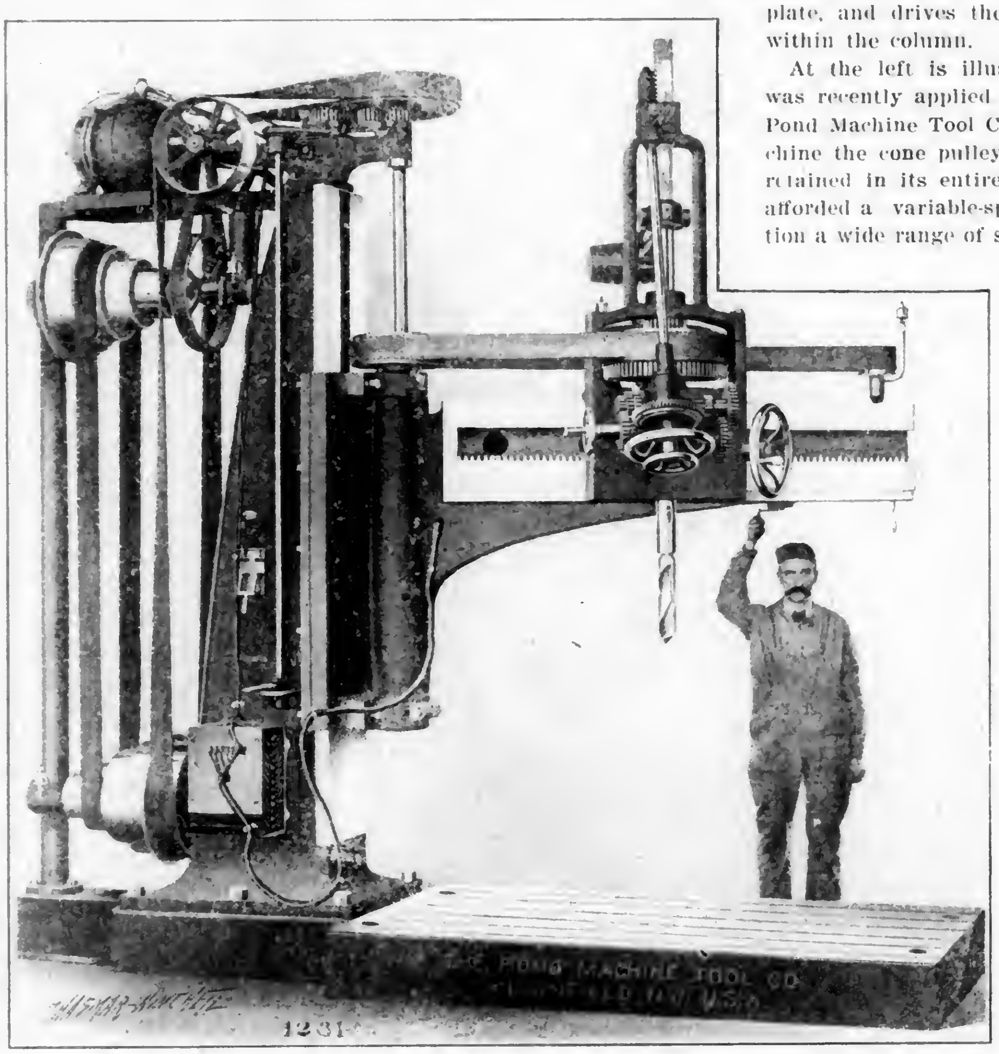
THE WELLMAN-STREET STEEL CAR.

WELLMAN-SEAVER-MORGAN ENGINEERING COMPANY.

MOTOR SPEED CONTROL.—We are in receipt of a valuable treatise upon the subject of speed control for electric motors, which has been reprinted from a paper entitled, "Methods of Speed Control," read by Mr. Wm. Cooper, before the American Institute of Electrical Engineers. It is an important paper, inasmuch as Mr. Cooper has in a singularly well-directed manner so chosen his remarks as to make clear many points which are the least understood, or those concerning which the experts upon motor driving differ in opinion; his remarks will be appreciated at present in view of the prevailing difference of opinion as to the relative advantages of direct and alternating current for electric driving equipments for shops. Mr. Cooper is an acknowledged authority upon this subject and is well known for his former connection during the past eight years with the Bullock Electric and Manufacturing Company, Cincinnati, Ohio. During his time there he devoted particular attention to a thorough study of the multiple voltage system of motor speed control, as well as also a very careful study of all other methods of speed variation for electric motors. All interested in this important subject cannot fail to be interested in the attitude that Mr. Cooper takes in regard to it, and we recommend his works to their attention. His present address, as consulting mechanical and electrical engineer, is 732 Union Trust Building, Cincinnati, Ohio.

plate, and drives the lower cone shaft through bevel gears within the column.

At the left is illustrated a type of individual drive that was recently applied to a 6-ft. plain radial drill built by the Pond Machine Tool Company, Plainfield, N. J. Upon this machine the cone pulleys and standard belt drive to the arm is retained in its entirety; in addition to the speed-range thus afforded a variable-speed motor is used, from which combination a wide range of speeds are available.

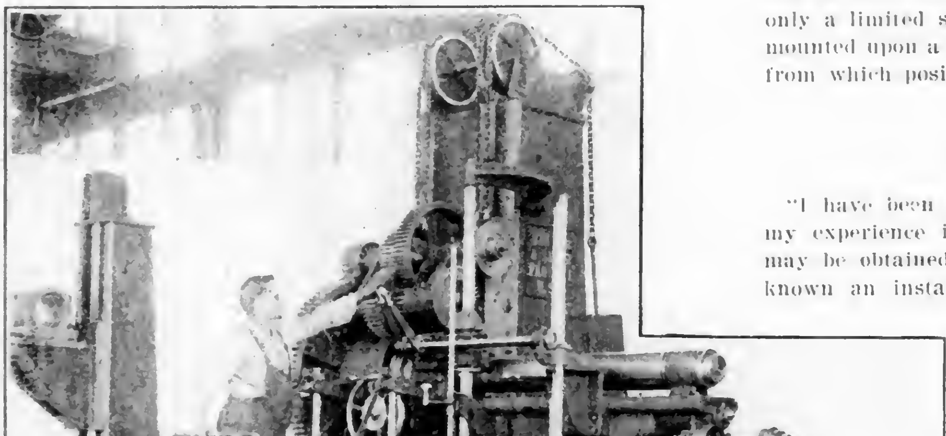


COMBINATION CHAIN AND BELTED DRIVE UPON A 6-FT RADIAL DRILL.—POND MACHINE TOOL COMPANY.

The motor, which is a 3-h.p. Lundell motor at 1,000 revolutions per minute, is mounted upon a bracket above the upper cone pulley, from which it drives that cone shaft by a Renold silent chain. The balance of the drive does not differ from that on the standard radial. The speed variation is obtained by field control, the hand controller being located on the arm as shown above the man's head; a flexible cable effects the connections between the controller and resistance box located on the side of the column.

The engraving below illustrates an individual drive upon a large horizontal-spindle drilling, boring and milling machine, which indicates an excellent arrangement for applying electric driving to a large tool. This tool is the No. 5 boring machine, with 9 x 12-ft. platen, built by Beaman & Smith, Providence, R. I., one of which was thus equipped for the new shops of the United States Navy Yard at Brooklyn, N. Y. The motor is a 10-h.p. constant-speed direct-current motor, supplied by the General Electric Company.

Only a limited number of different speeds are available from belt cone and gear changes in this drive, but on account of the large size of the tool and the character of the work to be handled, it is probable that only a limited speed range would be needed. The motor is mounted upon a bracket located in place of the driving pulley, from which position it drives direct through gearing.



GEARED DRIVE UPON A LARGE HORIZONTAL DRILLING AND BORING MACHINE. —BEAMAN & SMITH.

UNDISCOVERED MERIT.

"I have been some time in this world, and the result of my experience is that there is one way by which success may be obtained with ability. In all my life I have never known an instance of undiscovered merit. There are too many seekers to allow ability to remain hid. If you possess ability and were placed in a diving bell and lowered to the bottom of the sea, expeditions would be fitted out to discover you and bring you back.

"No matter what calling you embrace, if you have ability you will be in demand. If a lawyer, think how many persons there are in trouble who would be seeking your advice. If a physician, how many there are who are ill, who would want your services. If an architect, how many who desire better houses built. I have heard it said that a young man needs a pull to get a start. Pay no attention to that. If you have ability you will win."—The Hon. W. Bourke Cockran, in an address to the graduates of Manhattan College.

THE WELLMAN-STREET STEEL CAR.

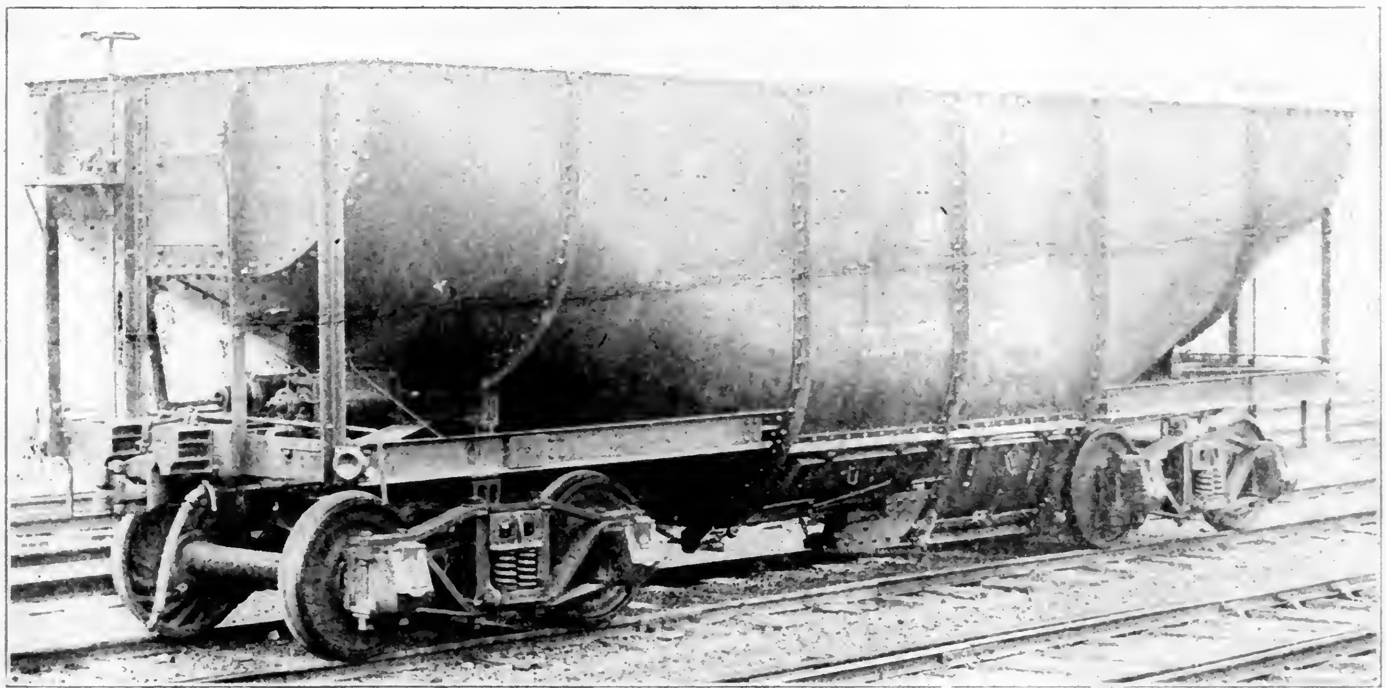
The accompanying illustration shows the general appearance of a new design of steel hopper car recently built by the Wellman-Seaver-Morgan Engineering Company, of Cleveland, Ohio, under patents issued to S. T. Wellman and Clement F. Street. This car is a radical and interesting departure from the designs in common use. The object was to reduce the number of points at which corrosion will be likely to take place, to produce a car which shall be self-clearing and also one which can be repaired at a low cost.

The center sills consist of two 15-in. channels with flanges turned toward the center. A gusset plate is riveted to the outside of each channel and extends from one center plate to the other. An angle iron is riveted to the lower edge of this gusset plate, forming a girder 27 ins. deep at the center, and extending from truck to truck. This girder is designed to have ample strength for carrying the entire load of 100,000 lbs.

It will be noted from the illustration that the side plates are curved, and that the customary form of side sill is entirely eliminated. The result of this curved form of plate is a car which will readily clear. A careful measurement shows that the lineal feet of joint exposed to load is 45 per cent. less than in the customary form of car. The manufacturers claim that as corrosion begins at these points, the life of this car will be very much longer than that of any other in use. The elimination of the customary form of side sill makes a material reduction in what the manufacturers of this car claim to be unnecessary dead weight, and this weight has been put in the plates of the car where it is believed to be more effective. These plates are 5-16 in. thick instead of ¼ inch, as in customary practice. One of the important advantages claimed is the large area of door openings. This is 56 sq. ft., while in most steel cars it is only from 20 to 25 sq. ft. This very large door opening, together with the curved form of plate employed, contribute to the clearing of the load.

The ends of the center sills of this car are tied together by a heavy steel casting, and this casting serves also for the central portion of the end sills. The ends of the end sills are formed of short pieces of 8-in. channels, securely riveted to the steel castings referred to and extending to the sides of the car. The push pole socket is riveted to these channels and also to a short 8-in. channel, which extends from the corner of the car to a heavy steel casting riveted to the side of the car close to the door opening. This construction is further stiffened by two angles extending from the corner of the car back to the body bolster near its junction with the center sills. As most of the damage to steel cars is caused by corner blows, this gives a construction which can be easily repaired. The idea is that under a corner blow the only parts receiving damage will be the channels and angles referred to. As these are commercial shapes they can be readily renewed, or if not too badly damaged they may be straightened and replaced.

This car was placed on exhibition at the recent convention of the Master Car Builders' Association, and created a great deal of interest among the railroad officers. The criticisms indicated a general feeling that this car presents valuable features and that its success is assured. The sample car has gone into exceedingly severe service, where its merits will be effectually tested. Further information may be had from Mr. Clement F. Street, manager of the railway department of the Wellman-Seaver-Morgan Engineering Company, Cleveland, Ohio.



THE WELLMAN-STREET STEEL CAR.

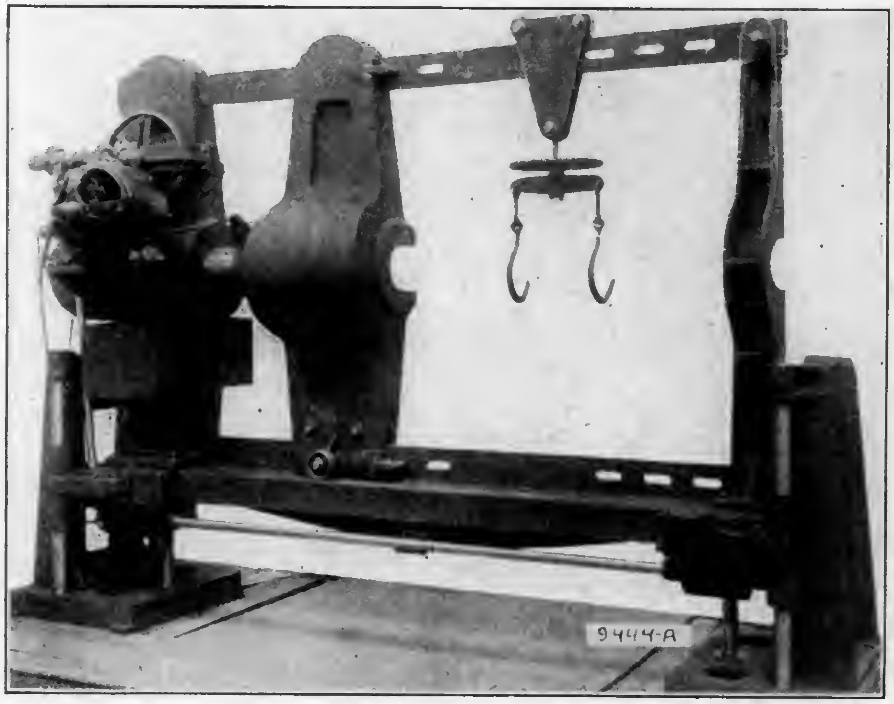
WELLMAN-SEAVER-MORGAN ENGINEERING COMPANY.

MOTOR SPEED CONTROL.—We are in receipt of a valuable treatise upon the subject of speed control for electric motors, which has been reprinted from a paper entitled, "Methods of Speed Control," read by Mr. Wm. Cooper, before the American Institute of Electrical Engineers. It is an important paper, inasmuch as Mr. Cooper has in a singularly well-directed manner so chosen his remarks as to make clear many points which are the least understood, or those concerning which the experts upon motor driving differ in opinion; his remarks will be appreciated at present in view of the prevailing difference of opinion as to the relative advantages of direct and alternating current for electric driving equipments for shops. Mr. Cooper is an acknowledged authority upon this subject and is well known for his former connection during the past eight years with the Bullock Electric and Manufacturing Company, Cincinnati, Ohio. During his time there he devoted particular attention to a thorough study of the multiple voltage system of motor speed control, as well as also a very careful study of all other methods of speed variation for electric motors. All interested in this important subject cannot fail to be interested in the attitude that Mr. Cooper takes in regard to it, and we recommend his works to their attention. His present address, as consulting mechanical and electrical engineer, is 732 Union Trust Building, Cincinnati, Ohio.

NEW DESIGN OF HYDROSTATIC WHEEL PRESS.

MOTOR DRIVEN, WITH SPECIAL ELEVATING MECHANISM TO OBVIATE THE USE OF CRANES.

The engraving presented herewith illustrates a novel design of wheel press, recently built for the Renovo shops of the Pennsylvania Railroad, by the Niles Tool Works' Company, Hamilton, Ohio, which merits attention for its elevating mechanism, whereby the entire machine may be raised or lowered to permit the various sizes of driving wheels to be rolled in without lifting. This design originated with Mr. H. D. Gordon, formerly master mechanic of the Juniata shops of the Pennsylvania Railroad, the special purpose of the design being to avoid the necessity of using cranes to place the wheels and axles in position.



NEW 400-TON WHEEL PRESS, WITH SPECIAL ELEVATING MECHANISM.

NILES TOOL WORKS COMPANY.

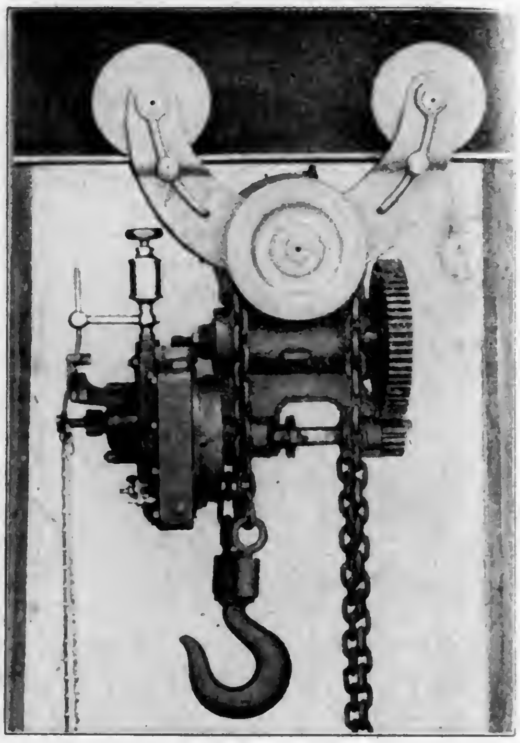
The machine is driven by a General Electric constant-speed, multipolar motor which is mounted upon a neat bracket at the rear of the hydraulic cylinder. The motor drives the pumps through a gear reduction, and also there is a bevel gear drive and clutch arrangement by which it may operate the elevating mechanism. The elevating mechanism consists of an elevating screw at each end, both of which are operated together by a worm on the long interconnecting shaft below the bed. The machine is guided in elevating by two stands bolted to the foundations, carrying heavy guide-rods. No gears for operating the elevating screws are running unless the machine is being elevated, a single lever being used to throw the elevating mechanism in or out of action.

The pump is double-acting, has two sizes of plungers and three speeds of delivery, and one or all of which are under instant control by trip-valves. The pressure-gauge is graduated for tons of pressure and for pounds per square inch on the ram. The sliding-head is supported by rollers running on planed ways on the base, and is held in position by large steel keys.

The maximum distance between tie-bars is 96 ins., while that between the end of the ram and sliding-head is 8 ft. 8 ins. The opening in the head for axles is 12 ins. The movable portion of the machine is mounted on a base-plate, to which, however, no strains are transmitted except those due to carrying the weight of the parts. All of the thrust is taken by the tie-bars.

THE DAKE PNEUMATIC AIR MOTOR AND CHAIN HOIST.

The accompanying engravings illustrate the design of this simple and very effective pneumatic air motor for general railway shop uses. The pneumatic chain hoist, which is shown in Fig. 1, consists of a Dake reversing air motor directly connected to an ordinary chain block of a standard make. Two pendant hand chains control the motor valve, to which is also attached a lever to operate the valve stem on the oil cup, giving automatic lubrication to the motor only when the hoist is being used. The worm and worm-wheel are of steel and phosphor bronze, and are enclosed in an oil tight case. All parts of the hoist are of sufficient strength to sustain a load of twice their rated capacity. The air motor used with this hoist is of the double reciprocating square-piston type of engine, and is favorably known as a desirable motor for direct



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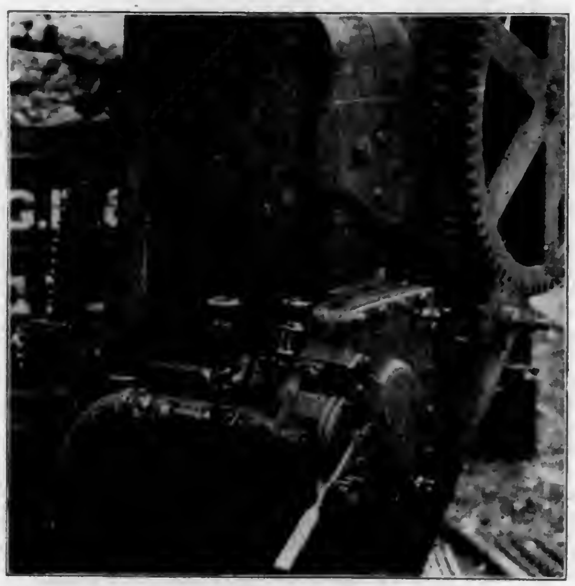


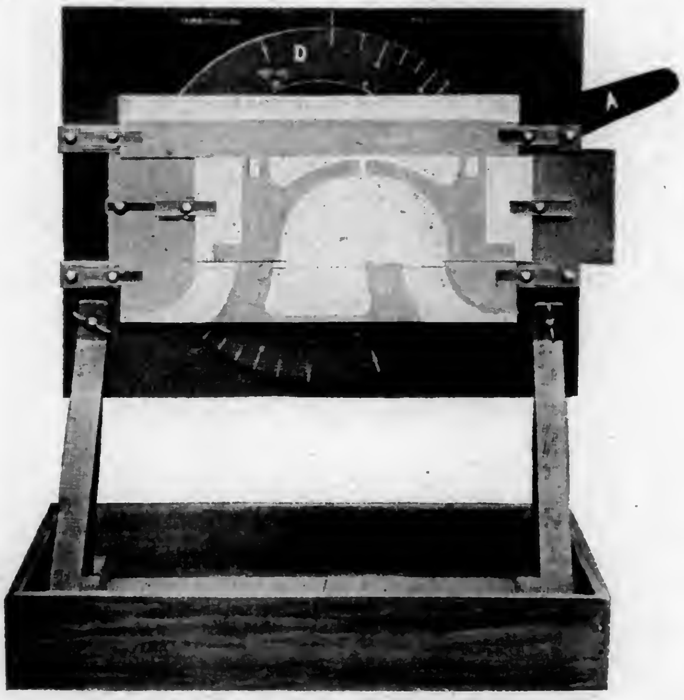
FIG. 2.—VIEW SHOWING APPLICATION OF THE DAKE AIR MOTOR TO A HAND CRANE.

connection work where it is desirable to use a small, compact and high-speed motor.

One of the many useful applications of the Dake air motor is shown in Fig. 2, which illustrates a hand crane that has been changed to a power crane by its application. The convenient form of this motor makes it a very desirable power for unloading derricks in freight repair yards, for railroad turntables, centrifugal pumps, fans, blowers and all classes of hoists. The Holland Company, 77 Jackson Boulevard, Chicago, are the manufacturers of this interesting device, and from them any desired information or drawings showing special arrangements of the hoist or any particular uses of the air motor can be had.

COMPACT VALVE MODEL.

A very ingenious and convenient model for the study of locomotive valve motion, developed by Mr. F. H. Colvin, is illustrated by this engraving. It is arranged for D valves of 5, 6 and 7-in. travels, for piston valves with both inside and outside admission, for the Vauclain piston valve and the new Wilson balanced slide valve. It is made of steel and is packed in a box 14 x 18 ins. When in use the box forms a base. The valve movement is ingenious and so arranged that one person can make adjustments, move the valve and study the movement, without the slightest difficulty. No wrenches are required, thumb screws being provided to put it together. The valves and seats are represented upon printed cards, which are secured in position by buttons, as shown in the engraving. Motion is obtained for the travel of the valve by a novel arrangement of slotted plate at the rear; this is turned by handle, A. The graduated disc, D, shows always at a glance the position of



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AN IMPROVED 15-INCH LATHE.

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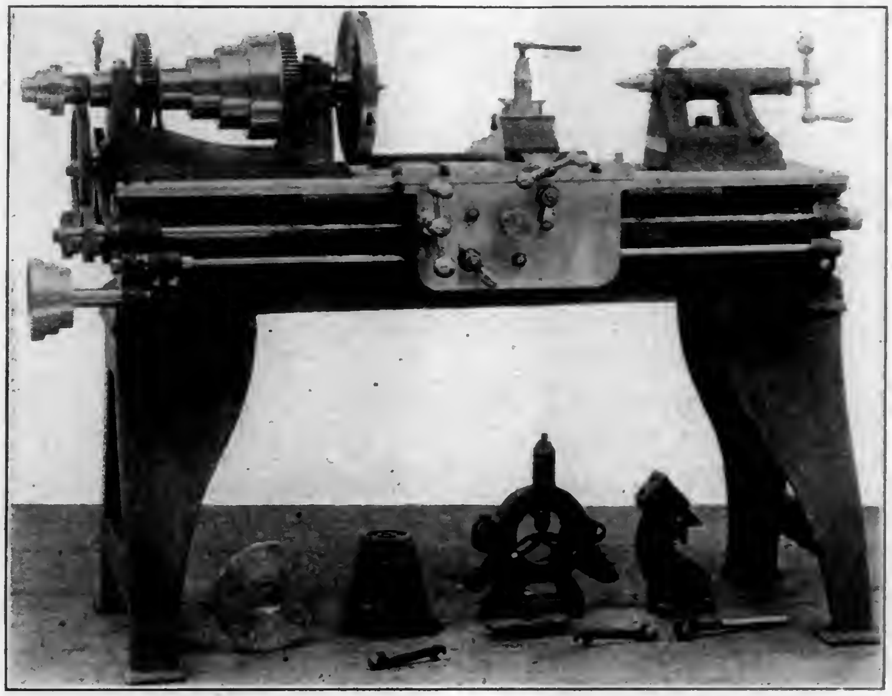
The engraving presented herewith is a view of the new model of the 15-in. swing engine lathe of the Sebastian Lathe



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Company, Cincinnati, Ohio. We desire to call the attention of of our readers to several important features in which the Sebastian lathe has of late been improved, bringing it entirely up to date and rendering it a rapid producer.

As may be noticed, all the parts appear heavy and substantial for a lathe of this size. The makers state that the live spindle is made of a high grade of special steel, the bearings are of the best phosphor bronze, and provision is made for constant lubrication. The carriage is of an improved design, has long bearing on the ways, and is provided with ample lubricating devices. It is gibbed to the bed both front and back. The lathe is arranged to cut either right or left hand threads, or feed either right or left. It has both screw and rod feeds, as well as power cross feed, and is provided with the usual number of extras, including steady rest; follower rest, large and small face plates, gears to cut from 5 to 36 threads, and a friction counter shaft.

SPECIFICATIONS.

Swings over bed	15 ins.
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Length of bed	6 ft.
Takes between centers	40 ins.
Front bearing	2 3-16 ins. diameter x 3½ ins. long
Hole through spindle	1 5-16 ins.
Weight	1,200 lbs.

THE CHICAGO-PACIFIC COAST RECORD BROKEN.

The special train which carried Mr. Henry P. Lowe from Chicago to Los Angeles, Cal., left Chicago at 10.17 A. M., August 8, 23 minutes after Mr. Lowe's arrival from New York on the "Twentieth Century Limited." The train, consisting of the dining car "Rocket," a baggage car and locomotive, was given right of way to Los Angeles, and stopped only for fuel and water. The run of 2,267 miles was made in 52 hours, 49 minutes, an average of 42.8 miles per hour. The total distance from New York to Los Angeles, 3,246 miles, was made in 73 hours, 21 minutes, thus establishing a new record.

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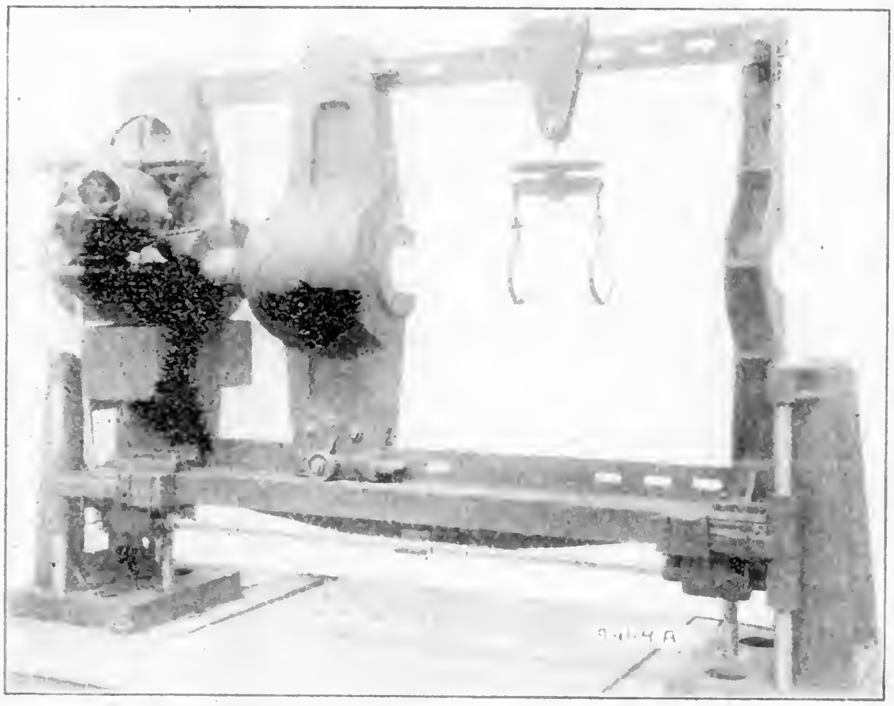

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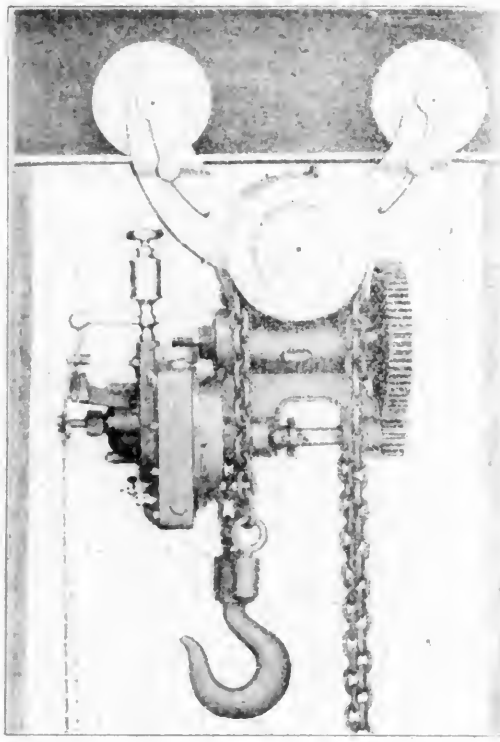

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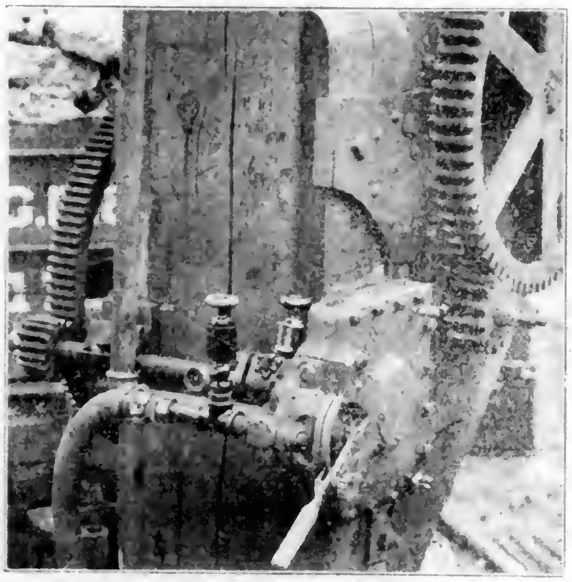

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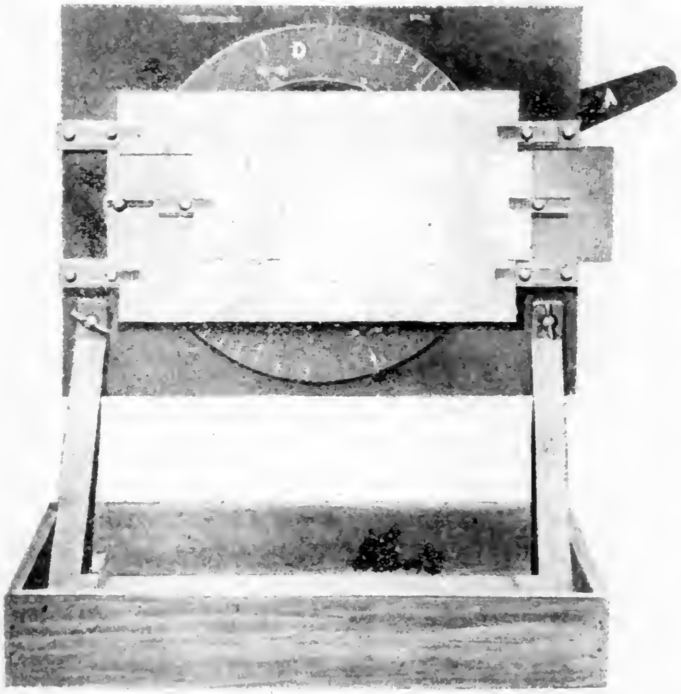

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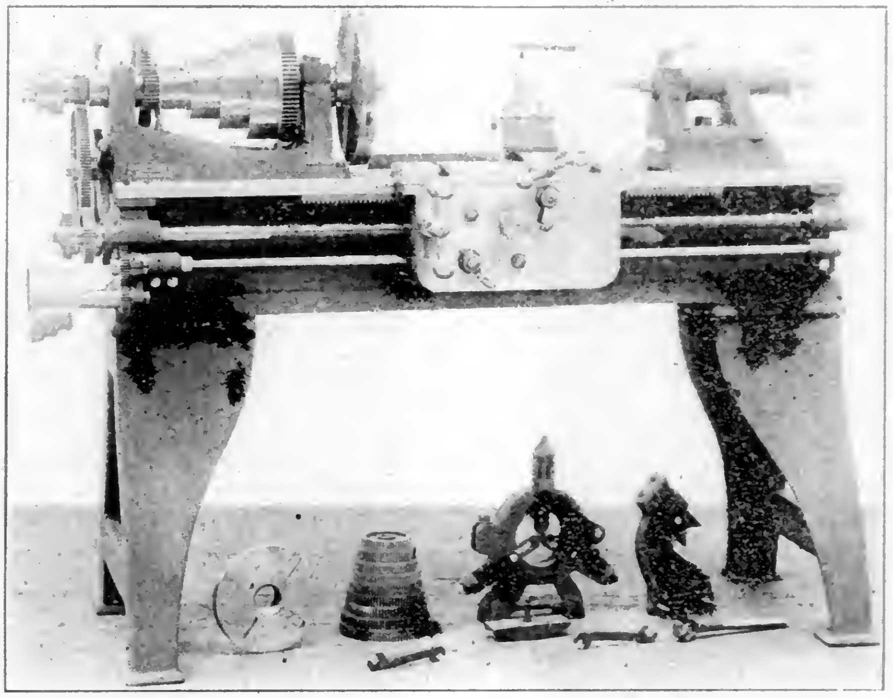

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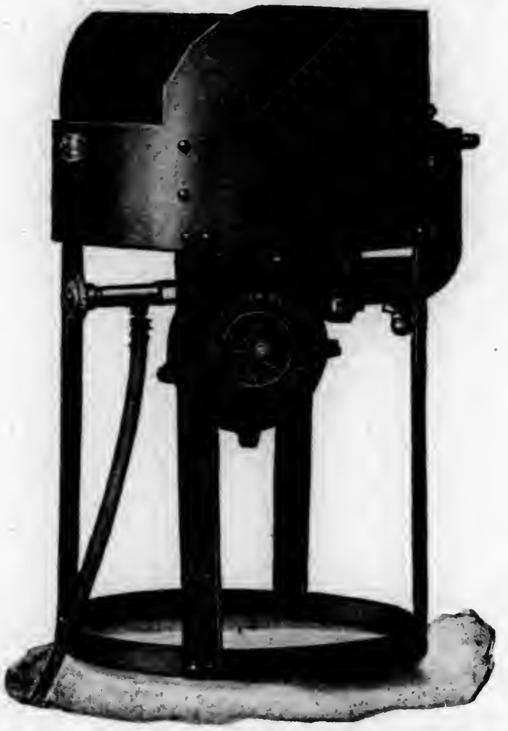
A NOVEL AIR OPERATED FORGE.

The Chicago Pneumatic Tool Company, Fisher Building, Chicago, have just placed upon the market a new design of portable blacksmith forge which is intended to operate by compressed air. It differs from the other forges built by this company in that it is to use with coal or coke, instead of fuel oil; fuel oil forges are also a specialty of the Chicago Pneumatic Tool Company.

The compressed air supply for the air forge enters through a hose and a ¼-in. standard pipe connection; it passes through a 1-16 needle valve jet, forcing the fan to revolve rapidly, and as the fan is open to the outer air, a blast of free air is con-



THE NEW CHICAGO AIR FORGE, OPERATED BY COMPRESSED AIR.

tinually blown through the tuyere. This method of using air to operate the fan, in addition to giving excellent results, effects a considerable saving in the amount of air consumption. This forge uses either coal or coke, coke giving possibly the best results. It operates with an air pressure of from 60 to 100 lbs., and consumes approximately from 5 to 7 cu. ft. of free air per minute. The fan revolves at approximately 4,000 r.p.m. at 80 lbs. pressure. It is 3 ft. high over all and the pan, or firebox, is 20 ins. in diameter x 10 ins. deep. The forge weighs 114 lbs. complete.

THE NEW WAUGH SPRING DRAFT GEAR.

The new Waugh spring draft rigging which was on exhibition at the recent M. C. B. convention is illustrated in the accompanying engravings in general construction and in action in service. The construction considered in detail consists of two pocket castings of steel, recessed 1 in. in the timbers and having flanged projections extending along the inner face of the draft sill and bolted through the timber to prevent the timbers from splitting. Two lugs are cast on the inner face of the pocket casting on which slide the abutment blocks, D, which are provided with oblong slots to fit over the lugs to allow the abutment blocks, D, to change position, as the followers travel in either direction.

The caps, E, are mounted upon the lugs to hold the abutment blocks in position and also to center the coil spring. The coil spring is a standard 8-in. x 6¼-in. double-coil spring. The plates composing the followers are all of spring steel, ¼-in. thick, 6 ins. wide and 12 ins. long. Groups B and B¹ are the main followers and are each composed of 8 plates of the above dimensions; groups A and A¹ are auxiliary followers and, as shown, are each composed of 6 straight plates of the same dimensions.

The thimbles, F and F, are inserted in either end of the coil spring, the inner ends of which come in contact ⅛-in. before the coil-spring is closed, thus preventing the coil-spring from being driven solid. Separating each auxiliary group of followers from the main group is a separating block, C, which is made up of two parts, one part provided with lugs, and the other with corresponding holes, and between the parts is a steel plate 1-16 in. thick, of the same length and width as the follower plates, simply to hold block C in the center. The

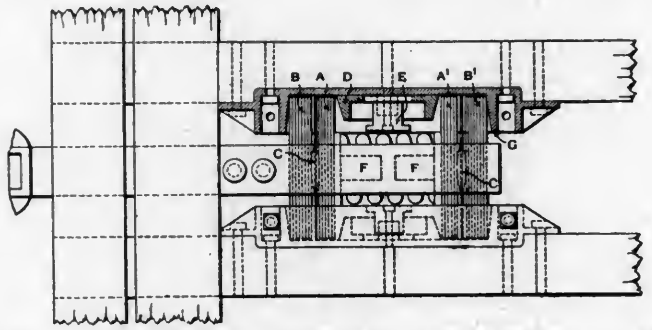


FIG. 1.—DETAILS OF THE WAUGH DRAFT GEAR, SHOWING ALL PARTS AT REST.

surface of block C in contact with the auxiliary group is an oval of ⅝-in. curvature, these being the curvatures taken by the auxiliary and main groups of plates when the coupler has traveled 2⅛ ins. in either direction.

In Fig. 1, in which all parts are shown at rest, the ends of the abutment blocks, D, are not in contact with the auxiliary groups, A and A¹, and the opening admits of the coil spring being compressed ⅜-in. before pressure is exerted on the auxiliary groups through the abutment blocks, D.

In service the gear has three distinct grades of cushion: The *first* is, when the coil spring has been compressed ⅜-in., the backward movement of auxiliary group A will slide the

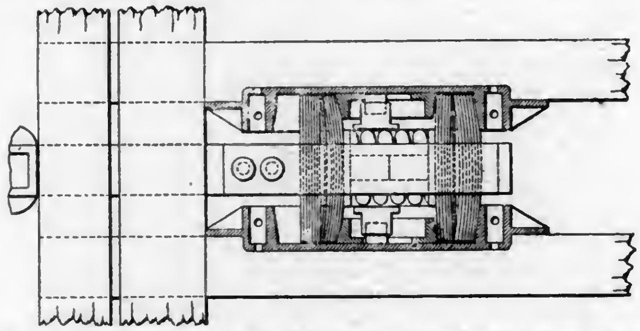


FIG. 2.—DIAGRAM SHOWING DISPOSITION OF PARTS WHEN THE COUPLER HAS REACHED ITS LIMIT OF TRAVEL.

abutment blocks, D, until they come in contact with the auxiliary group A¹, and in this travel about 7,000 lbs. of the capacity of the coil spring has been utilized. In the *second* action, the coil spring has been compressed 1¼ in. more, and each auxiliary group has been curved ⅝-in., but in opposite directions, by the abutment block D, and 83,000 lbs. of the blow has been absorbed on a total travel of 1⅝ in. It may be seen that the bearing shoulders of the pocket for the main followers are not at right angles to the wall of the pocket, but diverge at an angle which will allow the followers, B¹, to be curved ⅜-in. out of a straight line before taking the angle of the shoulder. In the *third* action, which is shown in Fig. 2, the thimbles in the springs are in contact and the pressure is directed along a center line through the thimbles F, and separating blocks C, to the center of the rear followers, B¹, the latter, when curved to the angle of the shoulders, making a total travel of 2 ins., having absorbed a blow of 183,000 lbs., as shown by a compression test.

When the coil spring has been compressed until the abut-

ment blocks are brought in contact with each auxiliary group, A and A', from that point to the limit of travel of the coupler, the force of the blow is resisted by front and back followers alike and in opposite directions through the abutment block, D; and so long as the coupler travels there is a resiliency in the spring plates and the draft gears or timbers do not receive a solid shock. With 2⅛ ins. travel of the coupler, only one-third to two-thirds of the elastic limit of the plates has been used. The adhesion of the smooth surfaces of the steel plates in each group by pressure through the abutment block to curve them, assisted by the check offered by the abutment block

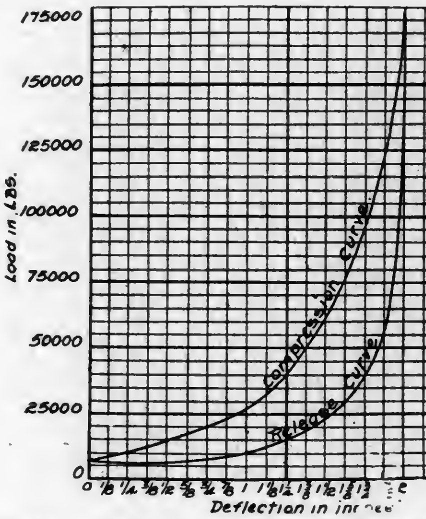


FIG. 3.—RESISTANCE CURVES OF THE WAUGH DRAFT GEAR.

to their return to a straight position until the coil spring is released, prevents the recoil; what has been shown of the action in buffing shocks is true under tensile strains. Tests made with different combinations of the plates show resistances of from 93,000 lbs. to 125,000 lbs.; 166,000 lbs. to 183,600 lbs., and 218,000 lbs. in 2 ins. of travel.

This device has been used by several railroad and car companies on high capacity cars, giving perfect satisfaction, and the 125,000 lbs. capacity has been adopted by some railroads on their passenger equipment. The gear, which was patented by Mr. J. M. Waugh, is manufactured and sold by the Waugh Draft Gear Co., Monadnock Block, Chicago.

BOOKS AND PAMPHLETS.

Equipment of a Railway Shop. A Description of the New Locomotive and Car Shops of the Lake Shore & Michigan Southern Railway at Collinwood, Ohio. (Abstract from the AMERICAN ENGINEER AND RAILWAY JOURNAL, October, 1902, to June, 1903.) Bulletin No. 35, 34 pages in pamphlet form, fully illustrated. Issued by the Crocker-Wheeler Co., Ampere, N. J.

The above is the title of an interesting pamphlet which was recently issued by the Crocker-Wheeler Co. in an attempt to set forth the important features of the large motor-driving equipment which they installed at the Collinwood shops. A complete and comprehensive description of the electric generating plant, the distribution system and the motor equipment for the drives is presented in a manner that cannot fail to be of interest to all who are concerned with the railroad repair shop problem. It undoubtedly constitutes the most complete exposition of the Crocker-Wheeler system of multiple-voltage motor speed control that has been published. In this installation the Crocker-Wheeler form I motor predominates, and numerous illustrations are presented showing various applications of them to the different machine tools. Also the merits of the mixed distribution system, comprising four wires for the variable-speed motors and two wires for the constant-speed motors and lighting, are set forth very clearly. This pamphlet is typographically a work of art; particular attention should be called to the design for the cover, which is symbolic of the advantages of the electrical method of driving shop machinery. It should be in the hands of everyone interested in motor-driving.

Manual for Engineers. Published by the University of Tennessee, Knoxville, Tenn. Third edition. Price 50 cents.

This is a little vest-pocket book of 224 pages, containing tables and data convenient for use of engineers and draughtsmen. Wherever space is available the pages are footed with terse paragraphs directing attention to the advantages of technical education. Its object is to bring to the attention of the men of affairs of the South the value of technical training. The fact that this is the third edition speaks for the reception given by the public. It is a very convenient little book. The compiler is Prof. Charles E. Ferris, of the University of Tennessee.

Experiments on the Flexure of Beams, Resulting in the Discovery of New Laws of Failure by Buckling. By Albert E. Guy. 1903. 122 pages. D. Van Nostrand Co., 23 Murray street, New York. Price $1.25.

This volume is a reprint of a series of articles which were recently published in the *American Machinist*. The first portion of the book is devoted to a discussion of the beam formulæ in common use, and the demonstration of their insufficiency to provide for the buckling tendency of the compression portion of the beam. The remainder of the work is given up to the description and discussion of the tests made by the author with the object in view of devising a formula applicable to slender beams. Certain laws are deduced and their similarity to the Euler column formula is shown. Altogether the book forms an interesting and valuable addition to engineering literature, and should lead to further investigation in this hitherto unstudied field.

The American Steel Worker. By E. R. Markham. 343 pages. 8vo. Fully illustrated. 1903. Published by the Derry-Collard Company, 256 Broadway, New York. Price $2.50.

This is a work of the utmost importance to all mechanics and shop men. The author, with his experience of twenty-seven years with the firm of J. H. Williams & Co., Brooklyn, N. Y., well known for their specialty of drop forgings, needs no introduction to those familiar with the technical press. He is an acknowledged authority upon all subjects relating to the selection, annealing, working, hardening and tempering of the various kinds and grades of steel, and these subjects have been treated exhaustively by him in this new volume. The wording is unusually clear and concise, and is in plain language, without any attempt at embellishment. Actual cases are cited, and the methods of treatment, as well as the results, are given in clear language. The illustrations are numerous and better than usually found. The index is very complete and affords a ready means for locating any information it contains. While nothing elaborate has been attempted, the binding, cover and general make-up are better than usually found in technical books, and will, we believe, be appreciated by readers.. We beg to call attention to the fact that the Derry-Collard Company will send a copy of this book anywhere in North America "on approval," according to their method, to be paid for or returned as desired. We are also pleased to note that purchasers of this volume are entitled to write and inquire of the author, Mr. E. R. Markham, care of the Derry-Collard Company, regarding any case of heat treatment of steel they may have which is not covered in the book; this will prove an important feature to the practical reader of this work, by whom it will be appreciated.

Modern Locomotive Practice. A Treatise on the Design, Construction and Working of Steam Locomotives. By C. E. Wolff. Illustrated with 150 engravings and 8 folded plates. Published by D. Van Nostrand Company, 23 Murray street, New York. 1903. Price, $5.00.

This is an English book, by an English author, and naturally is written from the standpoint of English practice. The first subject is train resistance; the next, type of express locomotives, followed by a discussion of the locomotive as a carriage, tracking and track construction. The other subjects are boilers, cylinders and valves, link motions, valve gears, connecting rods, crossheads and slides, crank axles, balancing wheels, brakes, modern locomotives and compounds.

Its greatest direct value is to English readers, but others will find many valuable discussions. In the absence of a thoroughly good and "up-to-date" treatise on the locomotive, any work on the subject is welcomed, but to attempt to properly justify this title in 265 pages is to fall short of what is so greatly needed. The book under review seems to deal with details rather than general principles and it treats only a few of the important details. The author should be encouraged to enlarge his work to four or five times its present size and apply Mr. Forney's ideal to present conditions.

The author approaches his subject from the standpoint of a student of mathematics, and while such treatment looks well in print, what is wanted is a presentation of English practice which will reveal the methods of the designers in attacking the problem of bringing out a new locomotive to meet certain definite conditions of train, grade and schedule. English locomotives are beautiful mechanically and they do remarkable work. American readers would like to know why this is accomplished with such relatively light engines. These comments are not offered in a spirit of fault-

finding, but in order to indicate the reviewer's idea of the opportunity which lies before him who knows how and has the information necessary to write a book on locomotive practice. It is not a matter of constructive detail alone, but capacity for steam making and steam using, that we all want to study. The book gives a valuable record of English practice but is not sufficiently complete.

Massachusetts Railroad Commissioners' Report, 1903. This volume of 700 pages contains the annual report of this commission, including observations upon the extension of electric railways, accidents, rolling stock, etc., and the usual voluminous statistics of the roads of that State, including the street railways.

Grinding and Polishing Machinery.—The Webster and Perkes Tool Company, Springfield, Ohio, have issued a pamphlet descriptive of their self-oiling bench and pedestal grinders, which will be of interest to railroad shop men. For modern self-oiling and dust-proof construction these machines are highly recommended, and merit attention from prospective purchasers.

Otis Elevators.—We are in receipt of a catalogue from the Chicago office of the Otis Elevator Company, describing the extensive line of passenger and freight elevators, both electric and hydraulic, that are built by them. The success which the Otis Company is meeting in the line of electric elevators is indicated by the fact that over 10,000 of their elevators of this type are in successful use. The catalogue also illustrates sidewalk hoists, plunger elevators, escalators, etc.

The Rand Drill Company are calling attention to the magnitude of their exhibit at the recent Master Mechanics' and Master Car Builders' conventions at Saratoga, by sending out a large illustrated card which presents a comprehensive view of their booth. Working models of their Imperial steam-driven compressor, their Imperial motor-driven compressor, their Imperial gas-engine compressor and their Imperial air hammers, piston air drills, and wood-boring machines, were shown in operation in the same, from which an idea could be drawn of the extensive character of their business.

Multiple Drills.—This is the title of a large 9 x 12 catalogue that has recently been issued by the Niles, Bement, Pond Company, of New York, relative to their various lines of multiple drilling machinery, with adjustable spindles. The magnitude of the production of this class of machine tools by this company cannot be appreciated without seeing the catalogue. The machines illustrated therein are of two general types—multiple drills, in which the spindles are adjustable to any position in a given line, and adjustable multi-spindle drills, in which the spindles may be arranged in a group of any shape or size within the capacity of the machine. These include not only their standard heavy multiple drills of Niles and Bement designs, adapted to railroad and general work, but also several machines of Pratt & Whitney Company's design, specially built for the drilling of duplicate parts in the manufacture of automobiles, typewriters, and other light work.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. W. O. Duntley, vice-president and general manager of the Chicago Pneumatic Tool Company, left Chicago recently for a several weeks' trip to the Pacific Coast in the interest of his company. He states that business in the pneumatic tool line is in a flourishing condition, and that in spite of the usual depression incident to this season the various plants of his company are yet working increased forces in order to take care of the business already on hand. We are also informed that their representative on the Coast, Mr. Henry Engels, located at 91 Fremont street, San Francisco, has lately secured a number of large orders for pneumatic equipment for a number of Western concerns, including a number of the Franklin air-compressors manufactured by the Chicago Pneumatic Tool Company.

The Falls Hollow Staybolt Company have opened an office in the Vanderbilt building, 132 Nassau street, New York, for the sale of their well-known hollow and solid staybolt iron. The office is in charge of Mr. Fred F. Bennett, who also represents C. B. Hutchins & Sons, Detroit, Michigan, manufacturers of freight car roofs and roofing materials. Mr. Bennett is well known to the railroad supply trade through his connection with the railroad press, the American Steel Casting Company and the Chicago Pneumatic Tool Company.

Portable quarters for workmen are one of the specialties that are handled by the Walter A. Zelnicker Supply Company, St. Louis, Mo. Quarters that can be easily and quickly moved as work progresses, and taken from one field of operation to another, will be of interest to contractors. The improved sanitary condition resulting from such an arrangement is also a decided advantage. The Zelnicker Company, who have these cars for sale, state that they can be furnished at prices as reasonable as that for which the ordinary huts can be built.

We are informed that the G. Drouve Co., of Bridgeport, Conn., are receiving many contracts for the installation of their improved Lovell window and shutter operating apparatus. Among their recent installations may be mentioned the Union Steam Pump Company, Battle Creek, Mich.; Ansonia Brass and Copper Company, Ansonia, Conn.; Cumberland Electric Light and Power Company's power-house, Nashville, Tenn.; the Union Typewriter Company's building, Syracuse, N. Y.; and the Monessan (Pa.) plant of the Pittsburg Steel Company.

The United States Graphite Company, Saginaw, Mich., sole miners of Mexican graphite, believe their No. 204 lubricating graphite to be the handiest as well as the most efficient supply of its kind for use in the engine-cab or roundhouse. They recommend it for use dry or in connection with oils and greases. Firemen will be interested to know that this product is also urged by the producers as the ideal pigment for the preparation of a locomotive front-end dressing—it is easily prepared, gives a fine, glossy finish, and it is claimed that it possesses unusual virtue for withstanding the trying conditions to which the front end is always subjected. This company offers to send free on request a quarter-pound can sample of dry lubricating graphite to any railroad man interested in its use.

Pneumatic Tool Patents.—An opinion was rendered Monday, June 29, by Judge Lacombe, of the Circuit Court of the United States for the Southern District of New York, in the suit of the Chicago Pneumatic Tool Company against the Philadelphia Pneumatic Tool Company on the Moffett Drill Patent, No. 369,120, of August 30, 1887, denying the motion of the defendant to dissolve the injunction which was granted against them some time ago, restraining them from manufacturing, selling or using portable pneumatic drills in infringement of rights under the above-mentioned patent. This decision is the result of continued efforts on the part of the Philadelphia company to escape this injunction and is most full and complete substantiation of the claims of the Chicago Pneumatic Tool Company.

The Westinghouse Traction Brake Company report a large number of sales of street-car air-brake equipments. Among the more recent may be mentioned the following, all of which equipments are provided with motor-driven compressors:

Seven equipments to the Wooster & Southbridge Street Railway Company.

Eight equipments to the Concord & Manchester Street Railway Company.

Twelve equipments to the Concord Street Railway Company.

One equipment to the Holland Palace Car Company for use on their new electric railway sleeping car.

The following is a list of some of the roads that have recently been equipped with their new magnetic brake and car-heating system.

Pennsylvania & Mahoning Valley Railway Company, New Castle, Pa.—Equipments for sixteen cars.

Morgantown Electric & Traction Company.—Equipments for twelve cars.

Washington & Canonsburg Railway Company, Washington, Pa.—Equipments for fifteen cars.

Altoona & Logan Valley Electric Railway Company.—Equipments for eight cars.

We understand that the Manhattan Elevated Railway Company, New York City, has drawn up plans to install moving stairways at its Thirty-third street and Forty-second street stations for both the uptown and the downtown platforms. It is believed that the company has been influenced by the fact that the receipts of the uptown station at Sixth avenue and Twenty-third street have increased at a greater ratio than at any other station of the system since the moving stairway was installed there, about two years ago. The contract between the city of New York and the Subway Construction Company provides that where station platforms are more than 30 ft. below the level of the street, mechanical conveyances must be provided; the Subway Company has accordingly arranged to install moving stairways at several of its stations.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

OCTOBER, 1903.

RAILWAY SHOPS.

BY R. H. SOULE.

VI.

The Passenger Car Repair Shop.

(Including the Paint Shop and the Transfer Table.)

Nearly all passenger car repair shops are of the transverse type, which generally admits of handling each car in and out of the shop as a unit, although a few such transverse shops are made wide enough to take two cars to each track, this arrangement being resorted to in order to secure compactness of layout, or to conform to some local condition or requirement. With two or more cars to the stall it is sure to happen that an unfinished car will frequently block a finished car, so that the capacity and output of the shop are unfavorably affected. With only a single car to the stall, maximum output may be obtained, but for a shop of given standing capacity the building must be longer and the average internal distances to be traversed by men must be greater. It is believed, however, that the single stall arrangement is generally to be preferred. Of the very few longitudinal shops in use, examples may be found at Altoona, Pa. (P. R. R.), McKee's Rocks, Pa. (P. & L. E.) and elsewhere. No known advantage attaches to the use of the longitudinal shop and layout conditions, and restrictions alone can account for it. Shops of the roundhouse form are used at Columbus Ohio (Penna. Lines), Roanoke, Va. (N. & W.) and Baltimore, Md. (B. & O.). Those at Columbus and Roanoke were built as freight car construction shops (for which they are very well adapted), and are only incidentally used for passenger car repairs; that at Baltimore, it is believed, is an old engine house, which was abandoned for road work, As neither the longitudinal nor the roundhouse forms are to be preferred to the transverse type for either the repair or the painting of passenger equipment cars, only the transverse type needs to be considered.

A typical and prevalent arrangement of passenger repair and paint shops places the two buildings on opposite sides of an intermediate transfer table and pit, and several such cases are listed in Table 11. Examinging this table, it appears that in general 20 ft. center to center is a sufficient spread for repair shop tracks, especially if there are no intermediate posts, so that a clear working space between tracks is guaranteed. It is noticed that Montreal and Readville, two new shops, have a spread of 24 ft.; but it is known that at Montreal many new passenger equipment cars are to be built, and construction requires more room than repairs, while Readville is a very wide shop (225 ft.), where posts to support the roof are a necessity. As regards span (for repair shops), it is evident that at Omaha, Burnside and Concord, two cars can be stood on each track, and at Readville three, but for shops to stand but one car on a track a span of 100 ft. seems liberal, although the proposed new shop of the Atchison, Topeka & Santa Fe at San Bernardino, Cal., is to be 110 ft. In advising a span of about 100 ft. it is assumed that space is thus obtained for car bodies and bench work only, the trucks being transferred to other stalls for heavy repairs, and moreover it is entirely possible that the evolution of shop design will justify a span greater than 100 ft. and permit of the introduction of an internal longitudinal track to serve all the stall tracks, and facilitate the handling (by push trucks) of seats, backs, sash trimmings, etc., between the different sub-departments. The stalls reserved for truck work should be equipped with overhead cranes or hoists, as modern heavy trucks cannot be economically handled without them.

In the case of the paint shop, both dimensions may be curtailed, and a track spread of 18 ft., center to center, appears to be sufficient and has been adopted in the large and modern paint shops at Collinwood, Burnside and Concord. A recent examination of a large new shop with tracks spread 20 ft., center to center, shows that room between stall tracks is actually wasted. Similarly, the roof span may be reduced from 100 ft. to 90 ft. and still give plenty of room for paint shop work; the 100-ft. shops at Baring Cross and Montreal are luxurious. Although a clear span of roof truss without intermediate supporting posts is greatly to be preferred in a repair shop, yet the roof truss may be cheapened and intermediate posts used to positive advantage in a paint shop, where they serve a useful purpose in supporting the adjustable trestles with which every modern paint shop should be equipped.

A height of about 20 ft. from floor to lower chord of roof truss is ample for buildings in which passenger equipment cars are to be handled; this height permits of the use of cranes or hoists in those bays of the repair shop where trucks are to be handled and turned.

In twenty years the width of transfer table pits (for handling passenger equipment cars) has increased from 60 ft. to 80 ft., the latter width being found at Elizabethport, Omaha and Burnside. At Elizabethport the pit is 800 ft. long and covers 64,000 sq. ft. or nearly one and one-half acres. With such large pits it pays to equip the tables with large and powerful motors, and some recent installations are speeded to run at 400 ft. per minute light, and 200 loaded. As passenger equipment cars cannot be conveniently handled by cranes, the transfer table becomes a necessity, although it takes up a great deal of yard room and stands idle much of

TABLE 11.—ESSENTIAL DIMENSIONS OF TRANSVERSE PASSENGER REPAIR SHOPS, PAINT SHOPS, AND TRANSFER TABLES.
(In some cases the figures are approximate only.)

		Repair Shop		Transfer Table			Paint Shop	
Place.	Railroad.	Spread of Stall Tracks C. to C. (Feet.)	Span of Bldg. (Feet).	From Shop to Pit (Feet).	Width of Pit (Feet).	From Shop to Pit (Feet).	Spread of Stall Tracks C. to C. (Feet).	Span of Bldg. (Feet).
Burlington, Iowa	C., B. & Q.	22	90	50	60	50	22	90
Chicago, Ill.	C. & N. W.	20	80	20	60	20	20	80
Elizabethport, N. J.	C. R. R. of N. J.	20	100	50	80	30	20	150
Collinwood, Ohio	L. S. & M. S.	20	100	23	75	16	18	160
Baring Cross, Ark.	M. P.	22	100	70	70	70	22	100
Montreal, Can.	C. P.	24	100	30	75	100	24	100
Omaha, Neb.	U. P.	22	175	85	80	35	23	175
Knoxville, Tenn.	Southern.	20	90	100	60	100	20	90
Burnside, Ill.	I. C.	20	160	80	80	25	18	160
Concord, N. H.	B. & M.	19	170	82	70	82	18	165
Bloomington, Ill.	C. & A.	21	90	17	70	38	21	90
Topeka, Kan.	A., T. & S. F.	20	90	65	65	15	20	90
Morris Park, N. Y.	L. I.	18	85	15	75	15	18	85
Readville, Mass.	N. Y., N. H. & H.	24	225	25	75	100	24	225
San Bernardino, Cal.	A., T. & S. F.	22	110	100	70	80	22	90
Altoona, Pa.	P. R. R.	Longitudinal shop.			60	80	20	134

the time. It is often, also, an obstruction to the free movement of men and materials between adjacent buildings, and it is believed that this objection will be met in some future installations by locating the pit on one edge of the property, with buildings on one side of it only. The distances between pit and adjacent buildings (as shown by Table 11) vary from a maximum of 100 ft. on both sides at Knoxville to a minimum of 15 ft. on both sides at Morris Park. The old idea was that in case of fire cars would be shoved out into the space between shop and pit; but experience showed that this was seldom or never done. Meantime, the development of fire protection, with brick buildings, concrete floors, fire pumps, electric fire alarm systems, watchmen's clocks, division walls with automatic sliding doors, etc., has minimized the fire risk. At the same time people are realizing that steps saved means money saved, and the present tendency is to bring as close together as circumstances permit all such buildings as constantly exchange business with one another; witness Collinwood, with distances of 23 ft. and 16 ft. on either side of pit. If the layout conditions permitted, an ideal arrangement would be to reserve, say, 40 ft. on repair shop side (sufficient for doors and a pair of six-wheel trucks) and, say, 15 ft. on paint shop side (sufficient for doors and a hand truck); with an 80-ft. pit this would mean 135 ft. between buildings, which, though a minimum, would yet be a considerable distance for men and materials to overcome. In extreme cases, where land was scarce or costly, the distances between pit and buildings could be further reduced, and, to compensate for the loss of external track storage space, additional intermediate stub tracks could be introduced; this has been done in several instances. In northern latitudes heavy snowfalls in transfer pits must be reckoned with. Three courses of treatment are open: The transfer table in a shallow pit may be equipped with snowplows or scoops and be kept running and manned during each fall of snow; the pit may be made very deep and the table shallow, in which case there will be storage space for a large volume of snow; and lastly, the entire pit may be covered with a shed roof. Modern practice favors the use of shallow tables with several rail supports, rather than deep girders with only two rail supports, which latter arrangement forbids the use of the frequent high-level cross footwalks with which every transfer table pit ought to be equipped.

TABLE 12.—OUTPUT OF PASSENGER CAR REPAIR SHOPS.

(Repair shops and paint shops considered collectively.)

Place.	Railroad.	Average Total No. of Cars. Under Repairs.	Output per Month.	
			Total.	Per Stall.
Boston, Mass.......	B. & A.	40	35	0.88
Morris Park, N. Y..	L. I.	38	43	1.13
McKee's Rocks, Pa..	P. & L. E.	5	7	1.40
Milwaukee, Wis.....	C., M. & St. P.	24	20	0.83
Aurora, Ill.........	C., B. & Q.	40	28	0.70
Roanoke, Va........	N. & W.	20	16	0.80
Sedalia, Mo........	M., K. & T.	12	20	1.66
Decatur, Ill........	Wabash.	12	13	1.08
Reading, Pa........	P. & R.	77	65	0.84
Elizabethport, N. J..	C. R. R. of N. J.	40	60	1.50
Detroit, Mich.......	M. C.	22	20	0.91
Bloomington, Ill....	C. & A.	20	29	1.45
Green Island, N. Y..	D. & H.	16	26	1.62
Chicago, Ill.........	C., R. I. & P.	17	27	1.59
Montreal, Can......	G. T.	17	25	1.47
Portsmouth, Va.....	S. A. L.	13	16	1.23
Brightwood, Ind....	C., C., C. & St. L.	18	13	0.72
Concord, N. H......	B. & M.	28	38	1.36
Albany, N. Y.......	N. Y. C.	120	155	1.29
Olwein, Iowa	C. G. W.	12	9	0.75
Topeka, Kan.......	A., T. & S. F.	30	42	1.40
Middletown, N. Y...	N. Y., O. & W.	10	16	1.60
Baltimore, Md......	B. & O.	46	69	1.50
Burnside, Ill.......	I. C.	55	61	1.11
Collinwood, Ohio.. .	L. S. & M. S.	41	75	1.34
Springfield, Mo.....	St. L. & S. F.	20	15	0.75

A wooden floor is most desirable for the repair shop, while a concrete floor, surfaced with cement, suits paint shop conditions best; this permits of forming gutters just outside of the track rails, by which car washings may be led off to the sewer. The fan system of hot-air heating is best adapted for these two departments. In the paint shop a liberal supply of warm, dry air judiciously directed will curtail the period of drying and increase the output of the shop. The amount of air supplied to the paint shop must be very much greater than that supplied to the repair shop. The temperature of the paint shop air supply may also be considerably higher, both on account of the drying problems and because the workmen are less actively employed in the paint shop than in the repair shop. These facts should be borne in mind in proportioning the heating apparatus.

As buildings for passenger car repairs and painting are necessarily broad, low structures, the conditions for day lighting from above are favorable, and the saw-tooth form of roof construction is applicable and has been used in some recent installations. When, however, ordinary skylights are used they should be located, to produce the best effects, between tracks rather than over tracks, although the latter arrangement is the more obvious one architecturally.

The upholstery shop, trimming shop, varnish room and storage space are accessories of the repair and paint shop departments concerning which there is no uniformity of practice, either as regards the amount of floor space reserved per car or their relative arrangement and grouping. On listing some twenty shops it is found that in some few cases these accessories are all adjuncts of the repair shop, in a few others are all incorporated with the paint shop, but in most cases are divided between the two, but not in accordance with any uniformity of practice. When considered collectively it is found that the floor space per car (including both cars in repair shop and cars in paint shop) averages about 263 sq. ft., which may be taken as indicating that 250 sq. ft. will answer and 275 sq. ft. will be liberal. It should be understood that the cabinet shop and the paint storehouse do not come under the head of accessories. The convenient grouping of these subdepartments and their relation to the repair shop and the paint shop has a considerable influence on the output of the shop. The point to be borne in mind is that although strippings and trimmings may be removed from cars in either the repair shop or the paint shop, they are almost always replaced in the paint shop.

Table 12 gives the output of a number of passenger car repair plants. The work of repairs and repainting is often carried on simultaneously, so that, in treating of output questions it becomes preferable to consider the two subdivisions collectively. It is not proposed to examine in detail into the causes which result in such wide variations of output; they are many and complex and can be discovered only by investigation on the ground, but it is a fact that two of the plants which show the lowest output have longitudinal shops, while all of those which show both a large total and a large unit output have transverse shops; it is also known that these latter have the best proportioned and arranged accessories and the most modern and effective heating arrangements. When attention is focussed on the problem of securing maximum output from a given plant it is at once found that cars should be fed into the shop as fast as finished cars are taken out, and that no stall should be allowed to stand unoccupied. Examining the table, it is evident, however, that a well designed and appointed plant, where work is done on a large scale, ought to yield an output of at least 1.50 cars per stall per month, meaning by a stall a piece of track which is actually used for standing cars under repairs; space for truck repairs and caboose work, if done in repair shop, and for tank work, if done in paint shop, should be extra. The cabinet shop will be treated under a separate head, and it is unnecessary to say that its equipment and arrangement, and its location relatively to the repair shop, have a large share of influence in affecting output.

The relative number of cars to be under repair shop treatment and paint shop treatment at the same time is somewhat uncertain, but it is believed that, in general, the paint shop should stand twice as many cars as the repair shop, or, to put it in another way, that one-third of the cars should stand in the repair shop and two-thirds in the paint shop.

(To be continued.)

NEW PASSENGER LOCOMOTIVES.

PACIFIC OR 4—6—2 TYPE.

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

At the Brooks works of the American Locomotive Company new locomotives of the 4—6—2 type have been built for the Chicago, Rock Island & Pacific Railway and are now in service. Mr. M. K. Barnum, superintendent of motive power, states that they are intended to haul trains of eight and ten cars on a 1 per cent. grade and maintain speeds of from 30 to 35 miles per hour. They are reported to be satisfactory in steaming qualities and in handling heavy trains at high speeds. The photograph shows at a glance the designer's successful efforts to produce an attractive appearance.

This design employs piston valves with internal admission and very short valve stems. The connections to the stems are made by links, the rockers being placed in front of the guide yokes. It also includes the Player radial trailing truck, which is giving excellent results under many wide firebox locomotives. In connection with the table of dimensions it will be noted that the main driving journals are 9½ by 12 ins.

At the front water leg of the boiler a water space of 4 ins. is provided at the mud ring, and this enlarges rapidly above, to secure space for delivery of water to the sides of the firebox. The tubes are 2 ins. in diameter and spaced at a pitch of 2 15-16 ins. There is a single "hen and chickens" fire door 28 ins. wide.

This engine has air brakes on the trailing wheels as well as the drivers. A comparison of a number of designs of this type of passenger locomotives is presented in the following table:

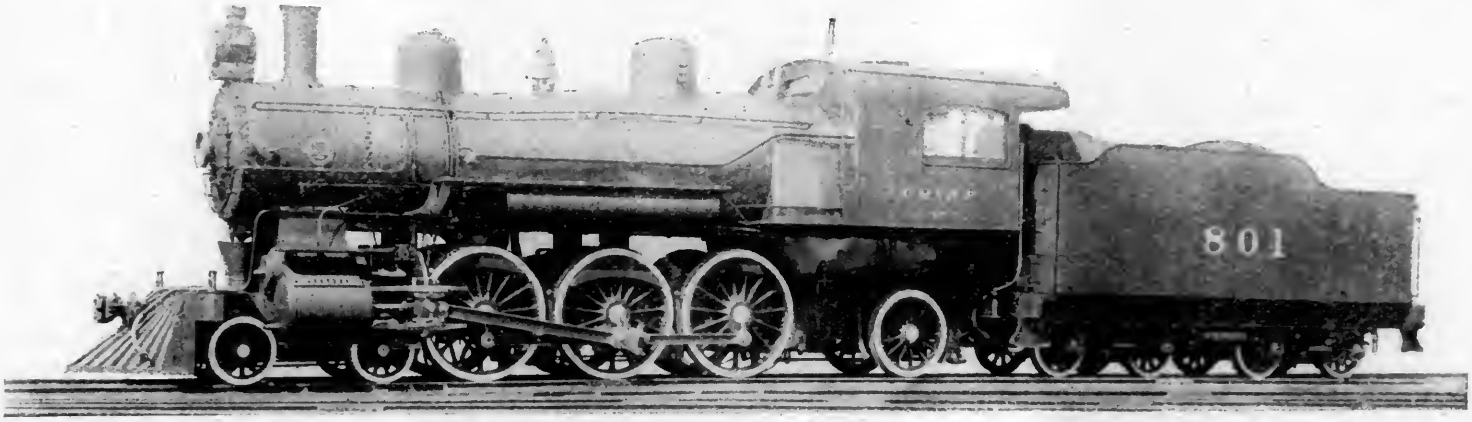
COMPARISON OF PACIFIC TYPE LOCOMOTIVES.

Road.	Total Weight.	Heating Surface.	Tractive Effort.
Chicago & Alton	219,000	4,078	31,600
Chicago & Alton	217,300	4,078	36,600
Northern Pacific	202,000	3,462	31,000
Chesapeake & Ohio	187,000	3,533	31,900
Missouri Pacific	173,000	2,953	25,700
Chicago, Rock Island & Pacific	192,800	3,104	28,300

RATIOS OF CHICAGO, ROCK ISLAND & PACIFIC LOCOMOTIVES.

Heating surface to cylinder volume	= 298.5
Tractive weight to heating surface	= 41.88
Tractive weight to tractive effort	= 4.59
Tractive effort to heating surface	= 9.11
Tractive effort × diameter of drivers to heating surface	= 629.
Heating surface to tractive effort	= 10.9%
Total weight to heating surface	= 62.11

Since this table was prepared the actual weights of the locomotive have been taken, which are as follows: On driving wheels, 132,300 lbs.; on leading truck, 32,300 lbs.; on trailing wheels, 28,400; total, 193,000 lbs. The chief dimensions are as follows:



PACIFIC—4—6—2 TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.
M. K. BARNUM, SUPERINTENDENT MOTIVE POWER AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, BUILDERS.

PACIFIC TYPE PASSENGER LOCOMOTIVE.

BUILT FOR CHICAGO, ROCK ISLAND & PACIFIC RAILWAY COMPANY.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	192,800 lbs.
Weight on drivers	130,000 lbs.
Weight engine and tender in working order	145,000 lbs.
Wheel base, driving	12 ft. 4 ins.
Wheel base, rigid	12 ft. 4 ins.
Wheel base, total	31 ft. 10 ins.
Wheel base, total, engine and tender	58 ft. 9 ins.

Cylinders.

Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	7 ins.
Diameter of piston rod	3¾ ins.
Size of steam ports	65 ins.
Size of exhaust ports	1⅞ ins. x 25½ ins.
Size of bridges	3 ins.

Valves.

Kind of valves	Piston
Greatest travel of valves	5½ ins.
Outside lap of valves	1⅛ ins.
Inside lap of valves	0 ins.
Lead of valves in full gear	1-32 in.

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	69 ins.
Material of driving wheel, centers	Cast steel
Thickness of tire	3½ ins.
Driving box material	Cast steel
Diameter and length of driving journals	9 x 9½ ins. diameter x 12 ins.
Diameter and length of main crank pin journals:	6½ ins. diameter x 6½ ins.
Diameter and length of side rod crank pin journals:	7⅜ ins. diameter x 4¾ ins.
Engine truck journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	33 ins.

Boiler.

Style	Radial stayed extended wagon top
Outside diameter of first ring	66⅛ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox:	11-16, 23-32, ¾, 9-16, ½, ½ in.
Firebox, length	84 ins.
Firebox, width	74 ins.
Firebox, depth	Front, 76½ ins.; back, 65 ins.
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ⅝ in.
Firebox, water space	4 ins. front, 3½ ins. sides, 3½ ins. back
Firebox, crown staying	1 in.
Firebox, stay bolts	1 in.
Tubes, number	300
Tubes, diameter	2 ins.
Tubes, length over tube sheets	18 ft. 7 ins.
Heating surface, tubes	2,940 sq. ft.
Heating surface, firebox	164 sq. ft.
Heating surface, total	3,104 sq. ft.
Grate surface	422 sq. ft.
Exhaust nozzles	5¼ ins. diameter
Smoke stack, inside diameter	15 and 17⅛ ins.
Smoke stack, top above rail	15 ft. 7 ins.
Boiler supplied by	Two 11 Nathan simplex

Tender.

Style	Eight-wheeled
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	18 ft.
Tender frame	13-in. channels
Tender trucks	Barber
Water capacity	7,000 U. S. gals.
Coal capacity	15 tons

STEEL CAR DEVELOPMENT.

Pennsylvania Railroad.

I.

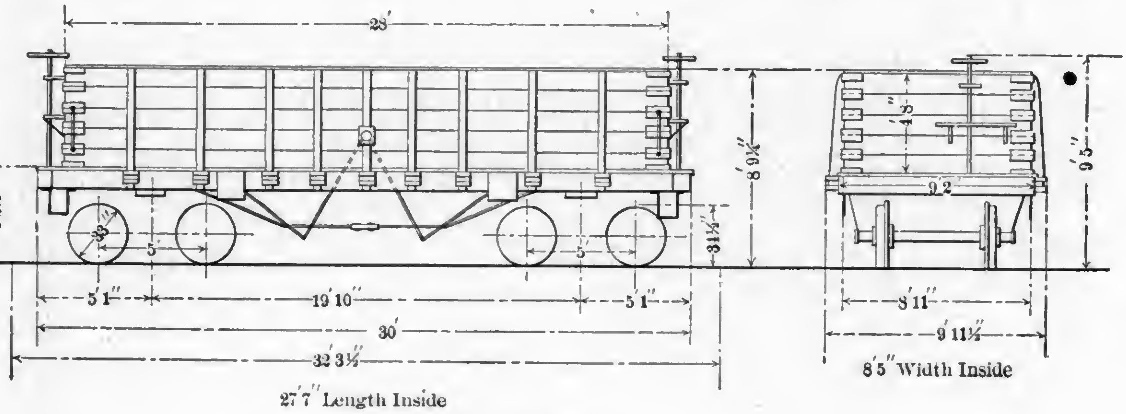
In January, 1896, the first steel cars for general service on the Pennsylvania Railroad were built by the Keystone Bridge Works, the beginning being contemporaneous with that of the Pittsburgh, Bessemer & Lake Erie Railroad, which was recorded in this journal in May, 1903, page 168. In fact, the officers of the Pennsylvania Railroad were intimately associated with those of the Carnegie Steel Company in the early stages of this development with respect to matters of design. Credit for the introduction of steel cars in this country therefore belongs equally to these two companies. The Pennsylvania system now has 46,696 steel cars in service, including those with steel underframes.

The Pennsylvania had built steel cars for special service dating back to 1887, when the Fd class were constructed. These weighed 51,800 lbs. and were designed to carry a concentrated load of 120,000 lbs. and were built for special service in transporting heavy wire rope cables for cable railroads.

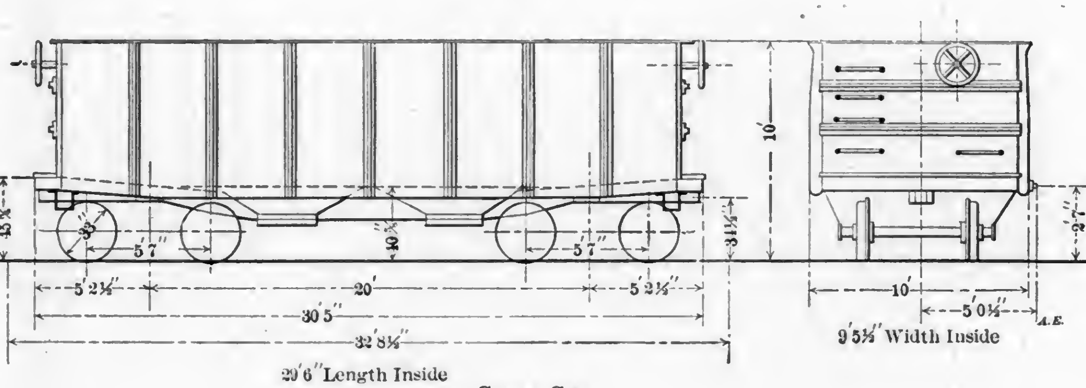
The class designations of the freight equipment of this road are as follows: Box cars, X; refrigerators, R; charcoal cars, L; stock, K; gondolas, G; flats, F; cabin, N; dump, U; wrecking or derrick, W. Suffix letters indicate succession in design, and second suffix letters indicate minor modifications of design, with reference to such details as height of sides and character of end doors, as in the case of gondola cars. In all cases the first letter designates the class.

In March, 1895, the Gg car was built from drawings prepared at Fort Wayne after a study of all existing types of heavy coal cars. It was a wooden hopper car and is believed to be the first large self-clearing hopper car ever built. This design has exerted a controlling influence over subsequent practice in steel cars. The first car weighed 35,200 lbs. and carried 70,000 lbs. of coal, the ratio of dead to paying load being 45.7 per cent. The original drawing of this car bears the date March 15, 1895, and the names of G. L. Potter, then superintendent of motive power of the Northwest System, and William Stephan, chief draftsman. The construction will be illustrated, because its general features were adopted in steel by the Schoen people, both on the Pennsylvania and the Pittsburgh, Bessemer & Lake Erie, and afterwards for general introduction.

In 1896 the Carnegie Steel Company were experimenting with steel cars, and at the same time the Gm steel car was designed by the Pennsylvania at Altoona. Five of these cars were built by Mr. Charles T. Schoen. They were gondolas with two small hoppers, but the car was not self-discharging. It had double drop-bottom doors. It was designed for use on the Pennsylvania Lines. Its cubical capacity was 2,038 cu. ft., including a heap averaging 9 ins. high above the tops of the sides. Its weight was 33,500 lbs. and capacity 100,000 lbs., giving a ratio of dead weight to paying load of 30.73 per cent. No other steel cars of this capacity have been built which weighed so little. This was the first steel car on the Pennsylvania and the five are now giving satisfactory service from the standpoint of maintenance, but the design has never been popular because of the necessity for shoveling the load through the drop doors. This car had no side sills, the sides being employed as trusses to assist in carrying the load. Thus this important principle, which seems to be considered a recent discovery, was embodied in the very first step taken by this road in its introduction of steel cars into general road service. These cars were carried on Vogt steel trucks and were fitted with single-spring double gear. The first Gm cars were delivered by the Pressed Steel Car Company, June 1, 1898.

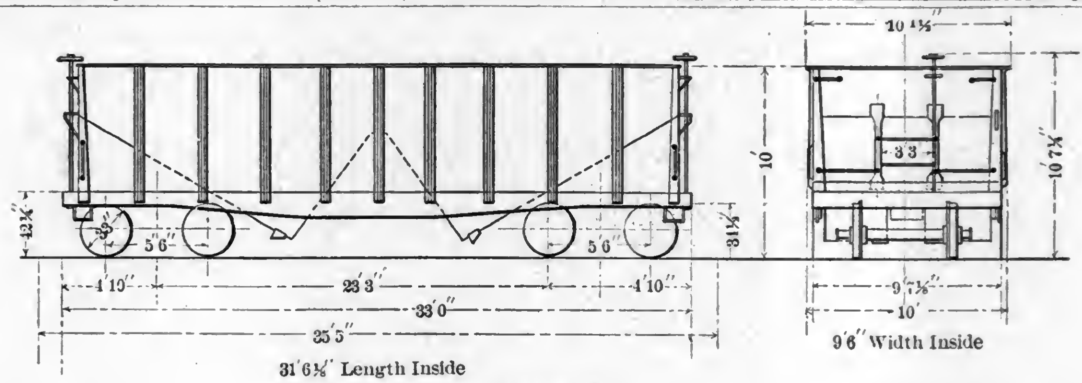


Class Gg.

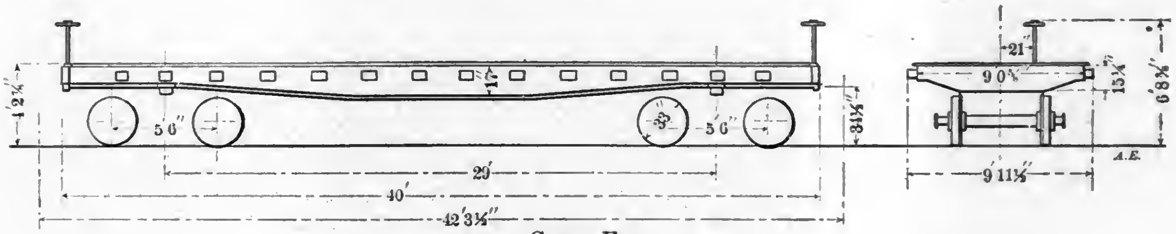


Class Gm.

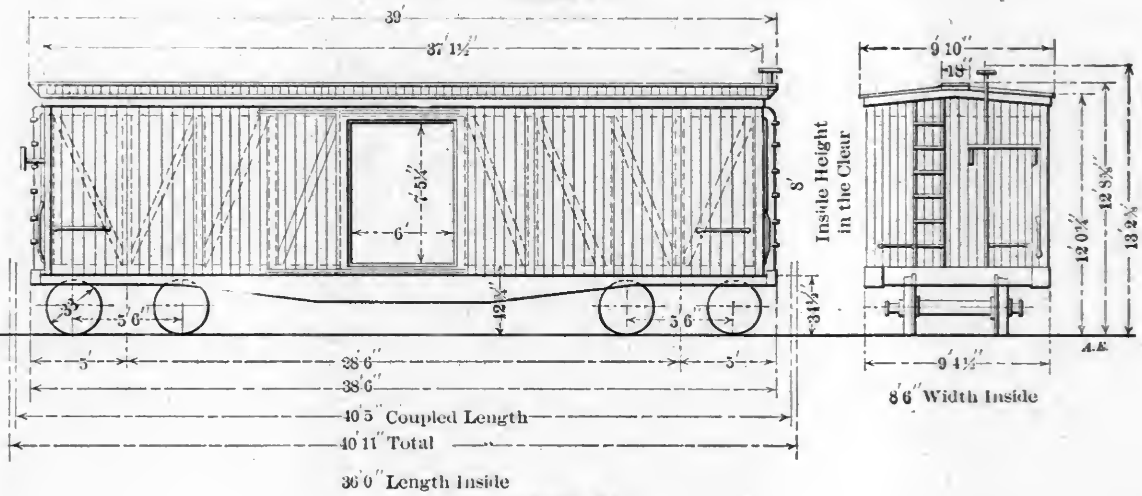
The Gl design was the result of conferences between the mechanical officers of the Pennsylvania Railroad, the Pennsylvania Lines West and the Schoen people. The drawings were contemporaneous with those of the Gm design, though the construction was later. The Gl car is a self-clearing hopper of 100,000 lbs. capacity and is now the standard of that type of equipment on the Pennsylvania system. This car is self-dumping and was very popular from the first. Its adoption as a standard gave steel car building a powerful



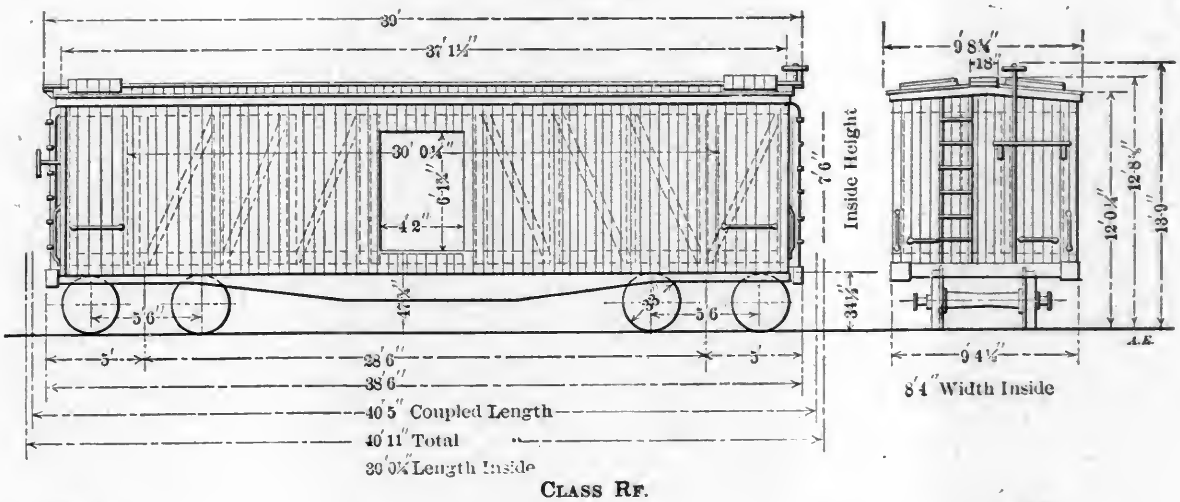
Class Gl.



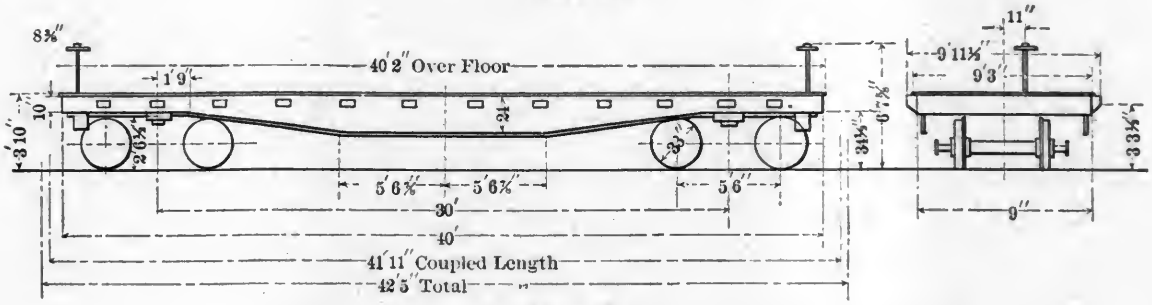
Class Fl.



Class Xl.



Class Rf.



Class Fm.

STEEL CAR DEVELOPMENT—PENNSYLVANIA RAILROAD.

impetus and it is interesting to note that this type has always led in popularity and that all self-clearing cars which have been built in large numbers have followed this general arrangement.

Details for the GL car were developed by the Schoen Pressed Steel Company and pressed steel was used in their construction. The first cars of this class were used on the lines west of Pittsburgh, carrying coal to the lake ports and returning to Pittsburgh with ore. For this reason it was a very profitable class of equipment and was from the first severely tested in service which was both important and conspicuous. Solid trains of these cars attracted attention to their advantages and this led to a very rapid development of facilities for building them, and these have been taxed to meet the demands for this equipment. The first GL cars went into service July 27, 1898.

This class is now practically the same as the original designs, but it is to be re-designed and lightened, without impairing its strength. For example, the side sills are pressed steel channels extending the full length of the car. These are not needed because of the very deep plate girders formed by the sides. Its dead weight is 36.36 per cent. of the paying load, as compared with 45.7 per cent. in the GG wooden hopper car.

An interval of about four years was allowed for a thorough service test of the GL cars both east and west of Pittsburgh

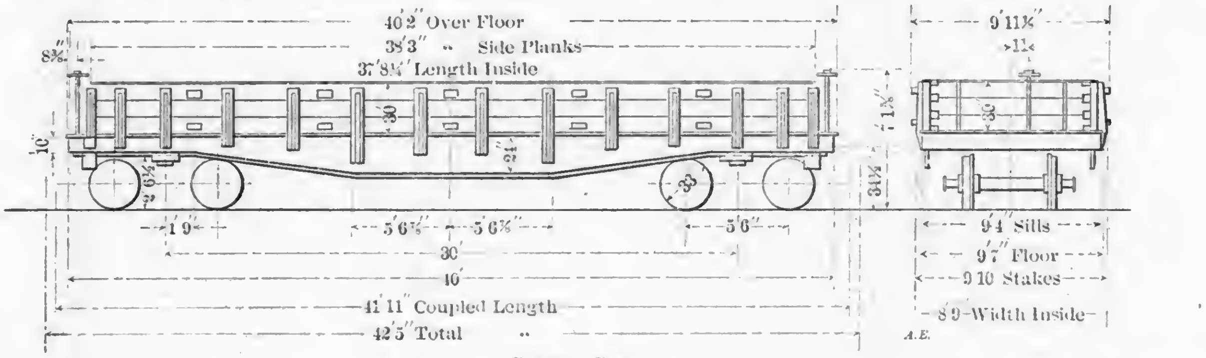
In the matter of sill construction the greatest depth of center and side sills for 33-ft. GL cars is 17 ins. For box cars 38 ft. 6 ins. long over end sills the depth is 17 ins. For concentrated loads and cars 40 ft. long or over the depth is 24 ins.; for uniform loads and cars of the GS types 40 ft. long the greatest depth of the center sill is 20 ins. There are no side sills in this design. This can hardly be said to constitute a rule of construction, but these depths have been established as satisfactory. More will be said later as to the sections of the sills and the necessity for reinforcing pressed steel channels for some of these classes.

STEEL CARS—PENNSYLVANIA RAILROAD.

TABLE OF CAPACITIES.

	Capacity				
Class.	Box.	Heap.	Total.	Pounds.	Weight.
GG	933 cu. ft.	175 cu. ft.	1,108 cu. ft.	70.000	35,200 lbs.
GM	1,861 cu. ft.	203 cu. ft.	2,064 cu. ft.	100,000	33.800 lbs.
GL	1,672 cu. ft.	225 cu. ft.	1,897 cu. ft.	100.000	39,150 lbs.
EL	Flat car			80,000	31,500 lbs.
XL	Box car			100,000	45,300 lbs.
RF	Refrigerator car			90.000	....
FM	Flat car			100.000	40,000 lbs.
GR	824 cu. ft.	247 cu. ft.	1,071 cu. ft.	100,000	44.000 lbs.
GS	1,331 cu. ft.	266 cu. ft.	1,597 cu. ft.	100.000	38,400 lbs.
GSA	1.379 cu. ft.	266 cu. ft.	1,645 cu. ft.	100,000	40,200 lbs.
GSB	1.312 cu. ft.	262 cu. ft.	1,575 cu. ft.	100,000	....
GSC	1,361 cu. ft.	262 cu. ft.	1,623 cu. ft.	100.000	39,800 lbs.

Next in order came the FL, an 80,000 lbs. capacity flat car. It was experimental and served to supply a great deal of information with reference to deflection and twisting of sills under loads. Class XL is the box car which was designed



CLASS GR.

before other designs were put into the form of construction. A number of experimental trucks were used and a careful watch was kept as to the performance of details. In the light of this experience several new car designs were prepared. An examination of the drawings indicates that these were based more or less closely upon a general scheme, which may be said to embody: (1) A backbone of two sills with cover plates, reaching nearly the full distance between the end sills. (2) Diaphragms in the bolsters with cover plates at top and bottom. (3) Bolsters 10 ins. deep at the center, with one top and one bottom cover plate. The bottom plate is wide at the center, to act as a gusset. (4) Two very heavy cross-bearers 24 ins. deep, to compel the sills to act together. These are used only on gondolas and flat cars, which are designed to carry concentrated loads. They are also used on GS cars which do not have side sills. In this case they are used for the purpose of transferring the load from the sides to the backbone on center sills. Other cars which, like box cars, do not carry concentrated loads, do not include these cross-bearers. (5) Diagonals from the ends of the bolsters to the ends of the center sills.

The later cars include flat, gondola, box and coke cars. The coke car is a design for special service and will be described later. The small diagrams indicate the character of this equipment. Another principle in this construction is the provision for "concentrated loads." It is assumed that two-thirds of the capacity of certain cars may be carried on a line at the center of the car or anywhere between the cross-bearers. The GR and FM classes provide for concentrated loads. GS is for a uniformly distributed load. It has a flat floor and solid ends. GSA has a flat hopper bottom and solid ends. GSB has no hopper and has drop ends. GSC has both hopper bottom and drop ends.

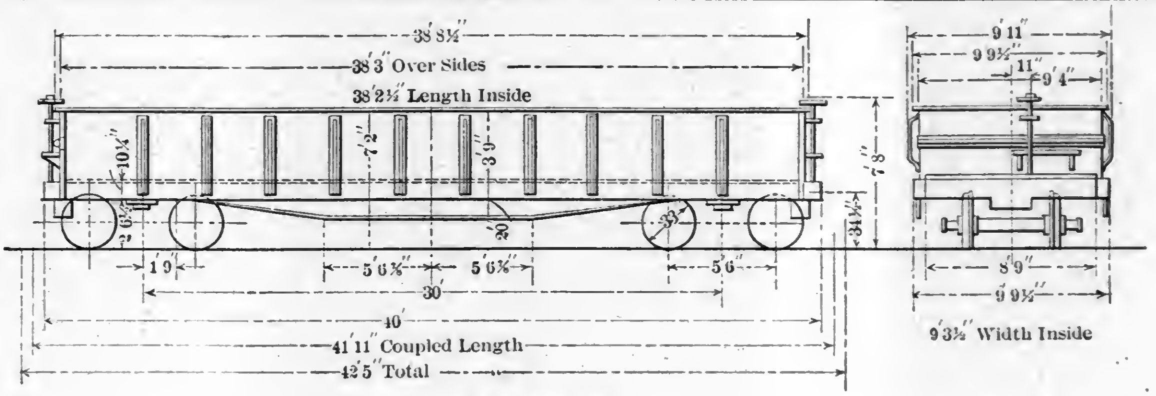
immediately after the American Railway Association had decided upon the dimensions—36 ft. long, 8 ft. 6 ins. wide and 8 ft. high as standard for 40-ton box cars. A capacity of 100,000 lbs. was decided upon because, the inside dimensions being given, the weight and cost of a 50-ton car would be little more than that of a 40-ton. It was found that 110,000 lbs. of grain could be loaded into this car, and this led to the decision as to capacity. No other class of box cars is now being built by the Pennsylvania. In all probability the cost of hauling a ton a mile is so low that with an occasional full load for a long trip, the cost of hauling the additional weight of a 50-ton over a 40-ton car could be earned several times every year. With pneumatic loaders cars may be loaded to the car lines with grain without hand trimming.

Class XL has a low floor to meet the standard dimensions. In this design cover plates and flange angles first appeared, the purpose being to gain strength. The greatest depth of the sills is 17 ins. and the neutral axis was raised by the cover plates. These cars are designed for distributed loads.

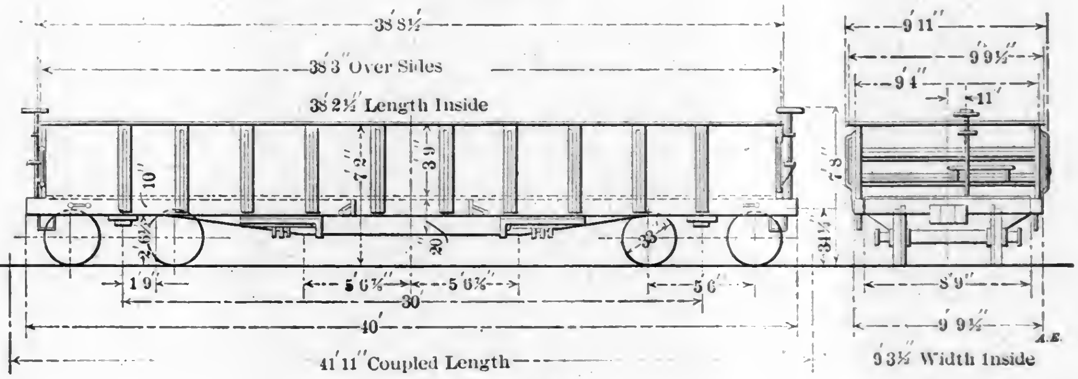
Class RF is a 90,000-lb. refrigerator, built to standard dimensions and with the underframe of class XL. These inside dimensions provided width enough to get in one more tier of boxes in box shipments than the previous standard and also gave room for larger ice boxes.

Class FM is a 100,000-lb. flat car, succeeding class FL. FM has 24-in. sills, which are the deepest pressed sills made, whereas those of FL were but 17 ins. deep. Class FM provides for concentrated loads and is strong enough to carry two-thirds of its capacity on the middle third of its length.

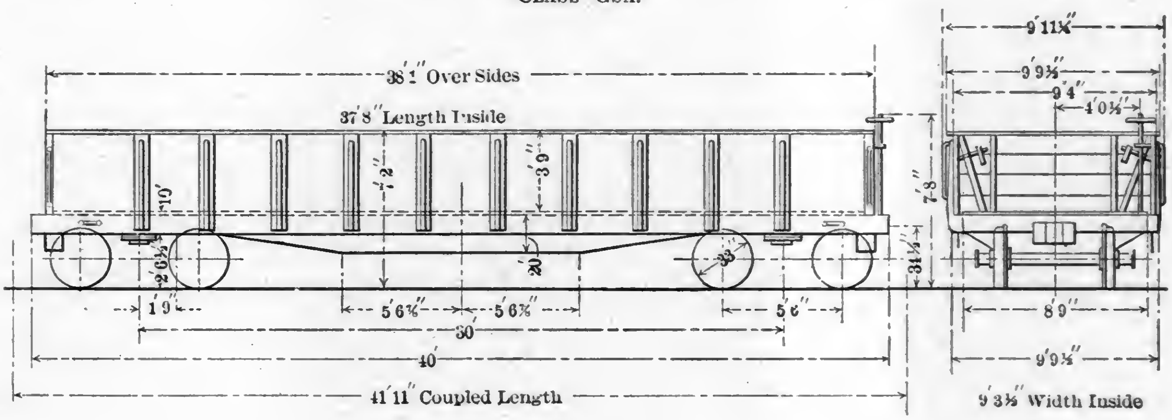
Class GR has practically the same frame as FM but could be made wider on account of the absence of stake pockets. This car was built for concentrated loads inside or on top of



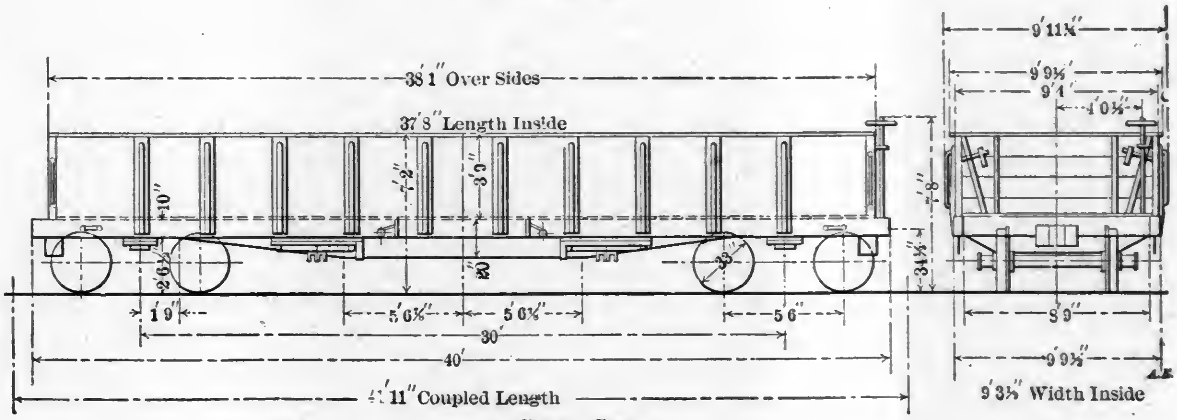
Class Gs.



Class Gsa.



Class Gsb.



Class Gsc.

STEEL CAR DEVELOPMENT— PENNSYLVANIA RAILROAD.

its sides. It has 24-in. center and side sills and wooden sides, not being intended for coal.

There are four subdivisions of the Gs class, all being designed for coal service on the lines west of Pittsburgh. The officers of this road believe that coal cars should have floors as nearly tight as possible in order to protect the substructure from corrosion, which would impair its integrity and strength. If a car stands with a load of coal containing sulphur, water will leach out the sulphur and form a weak solution of sulphuric acid, which is worse than a concentrated solution in its effects upon iron and steel. This weak solution does the work of a cape chisel and hammer. The box structure of a car may be easily patched and repaired, but this is not true of sills, bolsters and truck members. The Gs cars are the same length as Gr and have 20-in. center sills with no side sills. They all have solid floors.

Details of the most important of these designs will be presented, together with some further discussion of the principles involved in their construction. We are indebted to the officers of the motive power department of the Pennsylvania Railroad for courtesies in connection with this description.

NEW LOCOMOTIVE SHOPS.

READING, PA.

PHILADELPHIA & READING RAILWAY.

VII.

(*For Previous Article, See Page* 235.)

THE ELECTRIC POWER AND LIGHTING DISTRIBUTION SYSTEM.

The considerations which led to the adoption of the two-phase alternating current system of electric power distribution for the new Reading locomotive shops are interesting and very important. This question was given a very thorough investigation by the officials of the road and it is interesting to note the bearing that local conditions had upon the ultimate solution of the problem.

In the first place the plans for the shops included 14 electric cranes, varying in capacity from 5 to 120 tons, all of which would require variable speed motors, and some would have as many as six motions. The only type of motor naturally adapted to this class of service is the series, direct-current motor, having the regular street railway motor characteristics; the alternating current induction motor, even if arranged for variable speeds, was not considered satisfactory for work of this nature, which requires starting from rest under full load and accelerating rapidly. These considerations made it seem necessary that the power plant should supply direct current.

It was also planned to supply from the power plant, power and light to other departments of the road located in Reading, including current for 300 h.p. of motors at the car repair plant, 2,400 ft. distant, current for 145 arc lamps for illuminating the railroad yards and other departments in the city, together with several power transmissions from 1,000 to 3,000 ft. in length. For such service as this alternating current is much more desirable than direct current, as is well known. A careful study of these conditions resulted in a compromise in the matter, and it was decided to supply both alternating and direct current from the power plant in order to care for both classes of service.

ARC LIGHTING.

In this connection the question as to the type of arc lamp to use became a very important subject, as there are three prevailing systems of operating arc lights: First, the direct-current series system (requiring special series dynamos); second, the direct or alternating current multiple system; and third, the alternating-current series system (using series constant-current transformers). It was considered very undesirable to make use of the first-mentioned system on account of the complication that would be introduced into the power plant equipment by use of the comparatively small series dynamos. Consequently the question narrowed itself down to the exclusive use of the alternating-current series system throughout for both exterior and interior, or a combination of the multiple system for interior lighting and the series-alternating system for outside illumination, covering extended areas, as the multiple system was absolutely prohibitive for the latter work on account of the enormous amount of copper required for the distribution. Finally, however, the desirability of having a standard type of arc lamp, for both inside and outside use, thus reducing the number of spare parts to a minimum, together with consideration that the inside lamps were all to be located at sufficient distances above the floor to place them out of the way of harm and that the wiring was to be located in protected positions permitting high voltages, led to the adoption of the series, inclosed, 6.6-ampere, alternating-current lamp for both outside and inside use.

TYPE OF GENERATORS.

These decisions resulted in requiring that both alternating and direct current should be furnished from the power plant, after which the remaining question to be decided was the form of current that should be generated there as a primary basis of power supply. In determining this point, calculations were made of all the power that should be required for the various purposes for which it was to be supplied. The amount of power that would have to be supplied in the form of direct current for the crane motors and also for the variable-speed motors to be used for the individual drives on certain of the machine tools, and for all other purposes, was carefully determined; then the amount of power that would be delivered in the form of alternating current for the induction motors, to be used for all machinery requiring constant-speed driving, for the incandescent lighting and general shop distribution, for the long-distance transmissions, and also that to be used for the arc lighting, was also determined. The results of these calculations showed that only 150 kw. would be required for the direct-current distribution, while 1,050 kw. would have to be delivered in the form of alternating current, the latter being thus far the greater demand to be met. The relative merits of generating the current by the direct or alternating current systems were then considered, with reference to the adoption of the one most suitable for the governing conditions; the results, stated comparatively, are as follows:

ADVANTAGES OF THE DIRECT-CURRENT GENERATING SYSTEM.

(a) Satisfactory motors, both constant and variable speed, may be operated from the same mains.

(b) The power factor is 100 per cent., and this permits motors to start with a minimum of current.

(c) No trouble is experienced in the parallel operation of the generators.

(d) No exciters are required for the generators.

(e) There is no drop of voltage in the mains from inductive losses, as with alternating current.

(f) Slightly lower first cost.

(g) Motors have longer air gap than induction motors.

ADVANTAGES OF THE ALTERNATING-CURRENT GENERATING SYSTEM.

(a) It can readily be transformed from one voltage to another.

(b) Motors do not have commutators and brushes.

(c) The output is not limited by sparking at the brushes.

(d) It can be readily transformed from constant potential to constant current for operating the arc lamps.

(e) It is almost impossible for the armature, or rotating winding, of an induction motor to burn out.

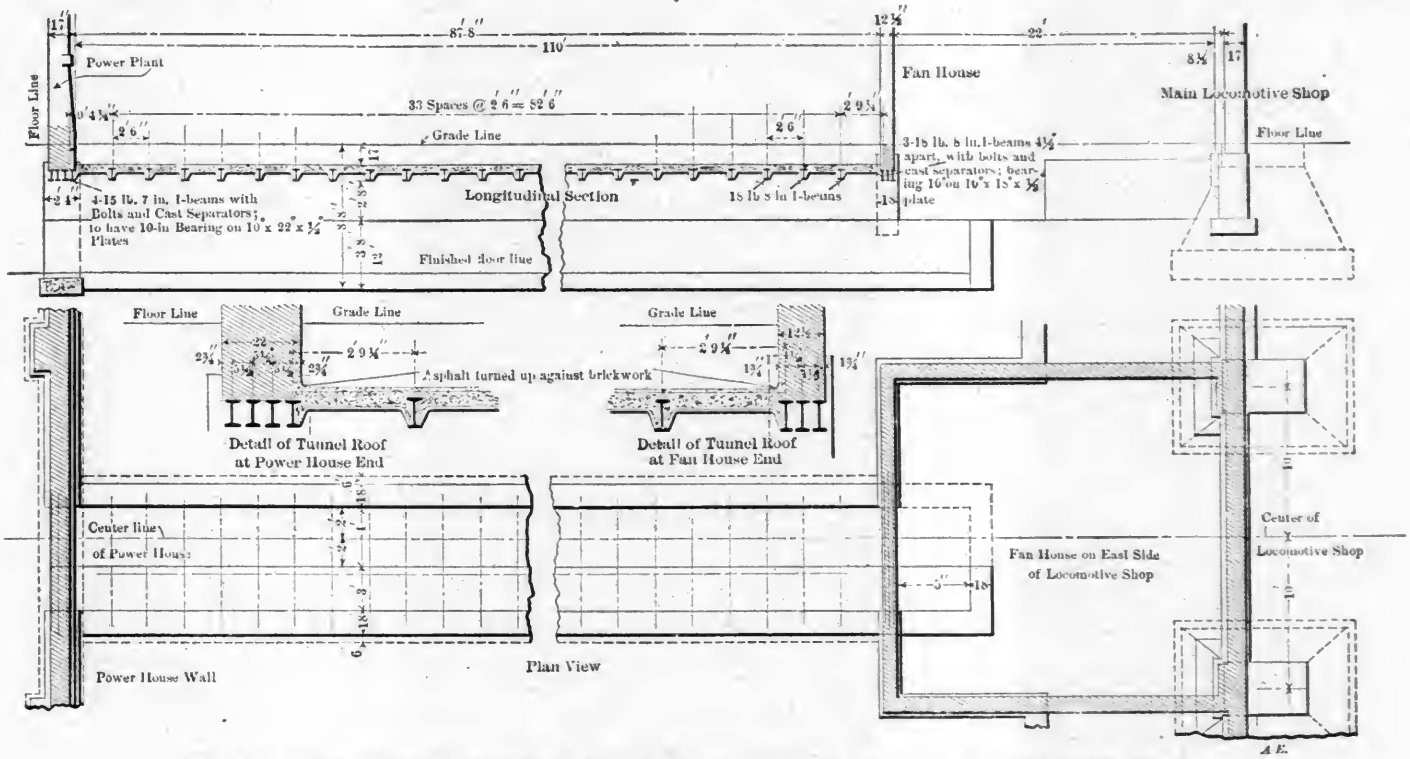
Thus for the plant in question, with several transmissions, constant current (alternating) to be supplied for the arc lamps, and with the alternating current demand so much greater than that for direct current, the use of alternating-current generators offered by far the greater advantages. It greatly simplified the station equipment, as with the multiphase alternating current, rotary converters could be used to transform into direct current the current supply for the crane motors, variable-speed motors, etc.

FREQUENCY AND VOLTAGE TO BE USED.

The number of alternations per second (frequency) at which the alternating current should be delivered from the generators was another important subject requiring attention. On account of the large number of induction motors to be driven, including the rotary converters, it was, of course, thought best to have the frequency as low as possible. But this was limited by the fact that alternating-current arc lamps were not built at that time which would operate satisfactorily at a frequency of less than 60 cycles (7,200 alternations per minute). But, as rotary converters to deliver 250 volts could easily be obtained that would operate satisfactorily, and also as induction motors are entirely satisfactory at this frequency, it was decided to adopt the frequency of 60 cycles per second.

In determining the terminal voltage of the generators, it was decided to operate with as high a potential as could be considered safe, which was especially feasible in the absence of danger from commutator troubles and also as the motors were to be located up on columns out of the way. Four hundred and eighty volts was the figure chosen for the generators, as being satisfactory for the standard induction motors and other alternating-current apparatus built by the two electrical companies supplying this class of machinery. This higher

voltage also has the advantage of reducing the cross-section of the feeders to a very small size as compared with what would have been required with the lower voltages.



DETAILS OF THE PIPING AND WIRING TUNNEL BETWEEN THE POWER HOUSE AND LOCOMOTIVE SHOP.
READING SHOPS.—PHILADELPHIA & READING RAILWAY.

NUMBER OF PHASES.

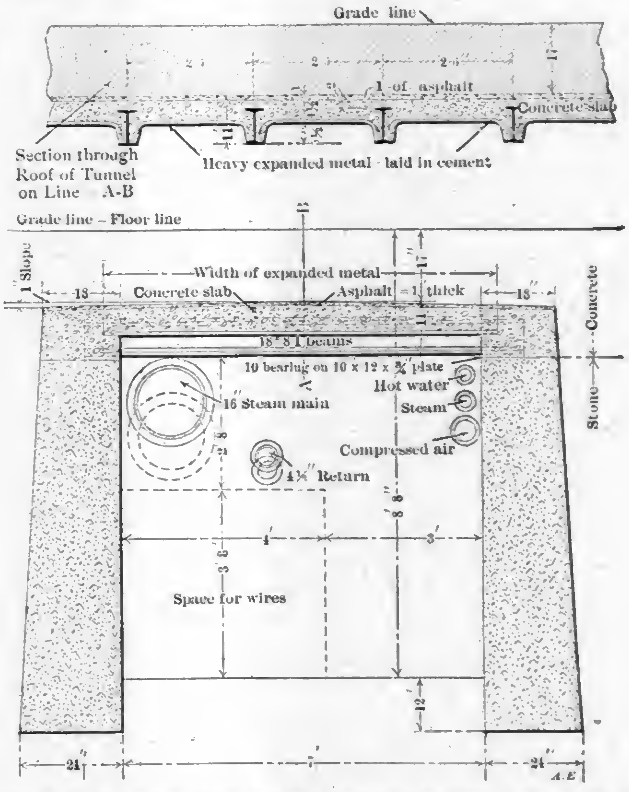
Inasmuch as the operation of large motors on single-phase alternating-current circuits is commercially impracticable, the two and three-phase systems were the only ones considered. In determining between the two, it was considered that, for a plant of this nature, with the great part of the distribution local and no long transmissions, the two-phase system would be more suitable. With the two-phase system there are but two circuits to balance, as compared with three of the three-phase system, and this is very easily done from the switchboard by means of double-throw switches, whereas, with the three-phase system, balancing is complicated. The two-phase system also offers a simple means of starting motors without the use of compensators, auto-starters, etc., as may be noted by reference to the description of the method used, which was published on page 237 of our June, 1903, issue in connection with the description of the power plant.

The two-phase system has the disadvantage of requiring more copper than the three-phase for the distribution system, but it was found that in a local distribution system, as in this case, and particularly with the high voltage used, this item does not become very large and is by no means prohibitive. Also the three-phase system offers distinct advantages over the two-phase system for long-distance transmission; but if a necessity for long-distance transmission should ever arise it was known that it would only be necessary to install a Scott phasing transformer, which would transform the current from two to three phase. In view of these numerous advantages of the two-phase system it was adopted as best suited to the local conditions.

This interesting plan of electrical distribution was worked out by Mr. E. E. Brown, Electrical Engineer, in charge of design and installation, under the direction of Mr. S. F. Prince, Jr., superintendent of motive power, to whom we are greatly indebted for courtesies extended in the preparation of these articles. Further considerations as to the distribution system and motor equipment will appear later.

DETAILS OF THE PIPING AND WIRING TUNNEL.

As stated in an earlier issue (see page 9, January, 1903) the central location given to the power house opposite the center of the locomotive shop, and the fact that the greater part of the power delivered was to be used in the locomotive shop, combined to bring the location of the wiring tunnel



CROSS SECTION OF THE PIPING AND WIRING TUNNEL, SHOWING DETAILS OF ROOF CONSTRUCTION.

very close to the center line of the locomotive shop building. In this way the tunnel also lent itself naturally to accommodate the piping systems that extend from the power house to the locomotive shop, for the steam, compressed air and hot-water supplies. The design of the tunnel, as well as the arrangement of the piping and wiring within it, are of interest.

The details of the tunnel construction are made clear in the two above engravings, one showing a plan and longitudinal section, and the other a cross section. **As may be**

seen, the shop end of the tunnel has its outlet in one of the heating fan houses. This is of considerable advantage, as a large space is afforded alongside of the heating fan for getting at the pipes and wiring, and for ease of arranging the distribution to the various departments. Also, as the fan rooms are kept locked, the piping valves and the wiring are, with this arrangement, not liable to be interfered with.

An important feature of the tunnel's construction is the roof, which is of concrete, braced by sections of heavy expanded metal which are laid between the 30-inch-spaced supporting I-beams; this is made clear in the cross section drawing. The concrete is covered by a heavy asphalt waterproofing, 1-inch thick, the whole being covered by puddled blue clay. The side walls are of solid concrete. The interesting construction of the roof at the power-house and shop ends of the tunnel is indicated in detail views below longitudinal section on page 357.

The arrangement of the various pipes in the tunnel is indicated in the cross-section view, which also shows the location of the wires. The "space for wires" is filled with the well-known McRoy vitrified clay 4-duct conduits, which are piled to fill the space. These accommodate the feeder cables that run from the switchboard in the power-house, which is located directly over that end of the tunnel to the distribution points. The feeder cables are all lead covered for protection in the tunnels.

As may be noted from the general dimensions of the tunnel interior, it is of sufficient size to permit ease of access, and repairs can be made with a considerable degree of comfort to the workmen—an important feature where good work is desired. The tunnel is well lighted by incandescent lamps, and also is well drained so that it is perfectly dry—an advantage for the electrical wiring.

STEEL FRAME, SIDE-DOOR SUBURBAN PASSENGER CARS.

Illinois Central Railroad.

III.

Previous articles on this subject were printed in this journal June, 1903, page 204, and September, page 327.

The underframe consists of four 9 in. 21 lb. I beams, 64 ft. long and spaced at nearly equal distances apart, giving a total width of 10 ft. 4 ins. over the flanges. The end sills are 9 in. 25 lb. channels set with the backs against the ends of the longitudinal sills and riveted to them with double angle plates and gussets. The underframe is trussed with four truss-rods passing over the inner body bolsters and anchored to the outer ones. Adjustment of these rods is provided by vertical green posts, under the 7 in. 15 lb. needle beams. Over the body bolsters and needle beams 6 in. 12¼ lb. I-beams in short sections are placed between the longitudinal sills as stiffening members and riveted to the webs of the sills by means of angles.

Upon the metal sills a steel floor of ¼ in. plates, 60 ins. in width, is laid with butt joints formed by the planed edges of the plates and extending entirely across the underframe. This floor is riveted to the upper flanges of the sills with double rows of ½ in. rivets. There is thus obtained a continuous metal surface extending the entire length and width of the car, insuring perfect rigidity of the underframe and giving complete protection from fire underneath the car. The underframe is carried upon four body bolsters made of 7 by 1 in. steel bars in the upper and lower members. The bolsters are arranged in pairs, 4½ ft. centers, and bolted to the lower flanges of the sills. Heavy truss connections extend between the bolsters, to which are bolted the center plates.

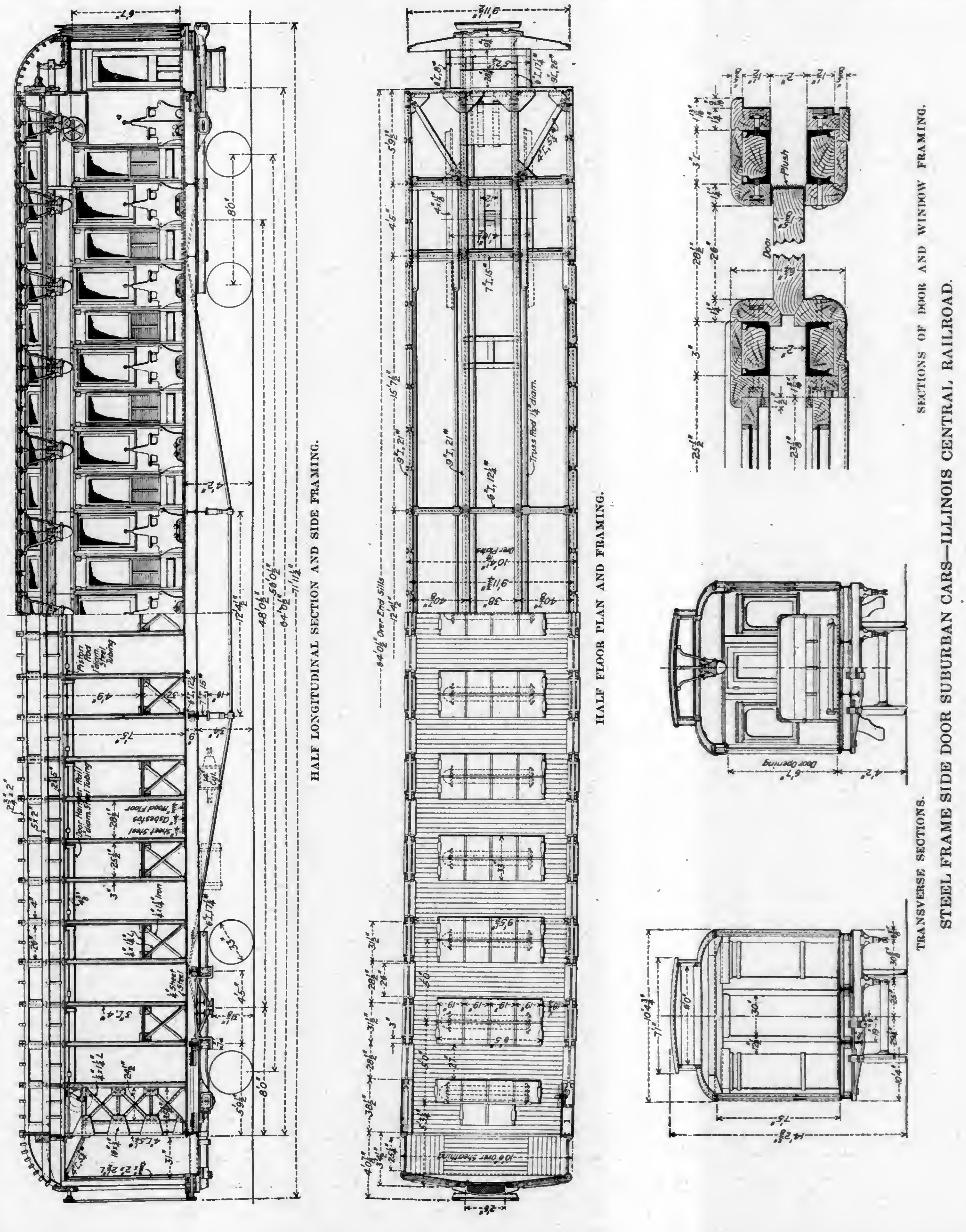
The upperframe is constructed of 3 in. 4 lb. channels with solid forged ends, which are riveted at the bottom to the top flanges of the side sills, and at the top to an iron plate 4½ by ½ in. which extends in one piece throughout the length of the car and the vestibules. The channels are spaced to form the window and door posts, and are set back to back 2 ins. apart so as to form hollow side walls, within which the doors slide when opened and closed. Below the windows a girth brace of 1¼ in. angle is riveted to the posts with gusset connections, to which the diagonal bracing of 1¼ in. angle and 1¼ by ¼ in. flat steel is riveted; this bracing at the lower end is shaped to form a foot, which is riveted to the lower part of the channel post and to the top flange of the side sill, thus reinforcing the post in its connection with the sill and forming a braced panel between each of the side-door openings. The corner posts consist of two 4 in., 5¼ lb. channels set transversely on the side sills and spaced 11 ins. apart. On the outside and inside of these posts four triangular gussets of ¼ in. by 15½ in. steel plate are riveted to the flanges, tying them firmly together; the corner posts are riveted securely to the side sills and to the upper plates with angle connections. The space between the corner posts and the adjoining side-door posts is braced with a double set of diagonal bracing, formed of 1¼ in. angles in three vertical panels and riveted to the gusset connections. This arrangement of corner bracing gives stability to the upper frame and forms a strong collision bulkhead. Across each end of the car the corner posts are connected by ¼ in. gusset plates to 5 by 4 by 7-16 in. angles and support oak end plates, to which are secured the side arms for the buffing mechanism of the upper portion of the vestibule diaphragm plate. Diagonal braces of 4 in., 5¼ lb. channels are riveted to corner posts and to the extreme end at side plates, which extend beyond the corner post of the body of the car to the corner post of the vestibule carried by the platform end sill. The vestibule corner posts are further reinforced by upright angles ⅜ by 2 by 2½ in. with flanged ends, which are bolted to the platform sills and at their upper ends riveted to the side plates and the end braces. The carlines are of ⅜ by 2 in. iron and are placed directly over each set of side-door posts, each carline resting directly on the side plates and secured thereto at each end by four ½ in. rivets, which pass through the forged foot of the carline, the plate and the forged ends of the channel door posts tying them all securely together. There is thus formed a continuous connection of metal framing throughout the entire body of the car.

An unique method of securing the exterior and interior finish to the metal frame has been adopted. Within the hollow of the channels forming the posts of the side-doors and windows strips of hard maple, 1¼ ins. thick and neatly fitted to the channels, were placed before the posts were assembled; the channel posts were then placed in a chuck upon the bed of a planer with the maple filler upwards, and with a specially designed tool the upper edges of the channel flanges were split to a depth of 3-16 in., and the inner portion of the flanges rolled down cold and turned over onto the filler, compressing and firmly enclosing it within the channel walls without the use of screws or bolts, thus making the filler an integral part of the channel and affording a secure and permanent foundation for attachment in the usual manner of the exterior and interior finish. A secondary system of continuous horizontal bracing extends throughout the walls of the car, adding materially to the resistance offered to a raking, corner or end thrust above the level of the floor. The roof is of 13-16 in. poplar, nailed to the strips in the usual manner. The floor is laid in three courses; first the steel plates forming part of the underframe, upon which is laid over the entire surface a covering of asbestos ¼ in. in thickness, and upon this a light flooring of wood is laid crosswise in tongued and grooved strips, and bolted to the steel floor underneath. The exterior finish is of poplar sheathing in vertical tongued and grooved strips, 2½ in. in width; the interior finish is of mahogany panels inlaid with delicate border design in marquetry, and is continuous throughout the walls and the vestibuled ends of the car.

All of the floor space of the car including vestibules is available for passengers and the vestibule doors are arranged to permit of passing from car to car in the trains. The platform traps open against the ends of the car and the vestibule side

doors swing across the ends of the slide aisles, serving as barriers for the protection of passengers. The vestibule entrances and steps are provided in order to permit the use of the cars in excursion service. They are not required in the regular suburban service.

The seats are of an entirely new design, in bench form, arranged transversely in sections, each section seating eight passengers. They are constructed throughout of mahogany, with straight backs 42 in. high, provided with swell panels for back rests. No upholstering is used. The seat bottoms of solid mahogany are of molded form, mounted on trunnion bearings in frout and supported on springs in the rear; each passenger having an independent seat separated from adjoining seats by short arms. These seats are designed to discourage "sprawling." They are most comfortable when the occupant is sitting upright in a position which economizes space. This is an important new principle in suburban car seating. There are twelve sections of seats, with two additional seats at each end of the car, making a total of 100 seats. Between the seat ends and the walls on each side of the car is an



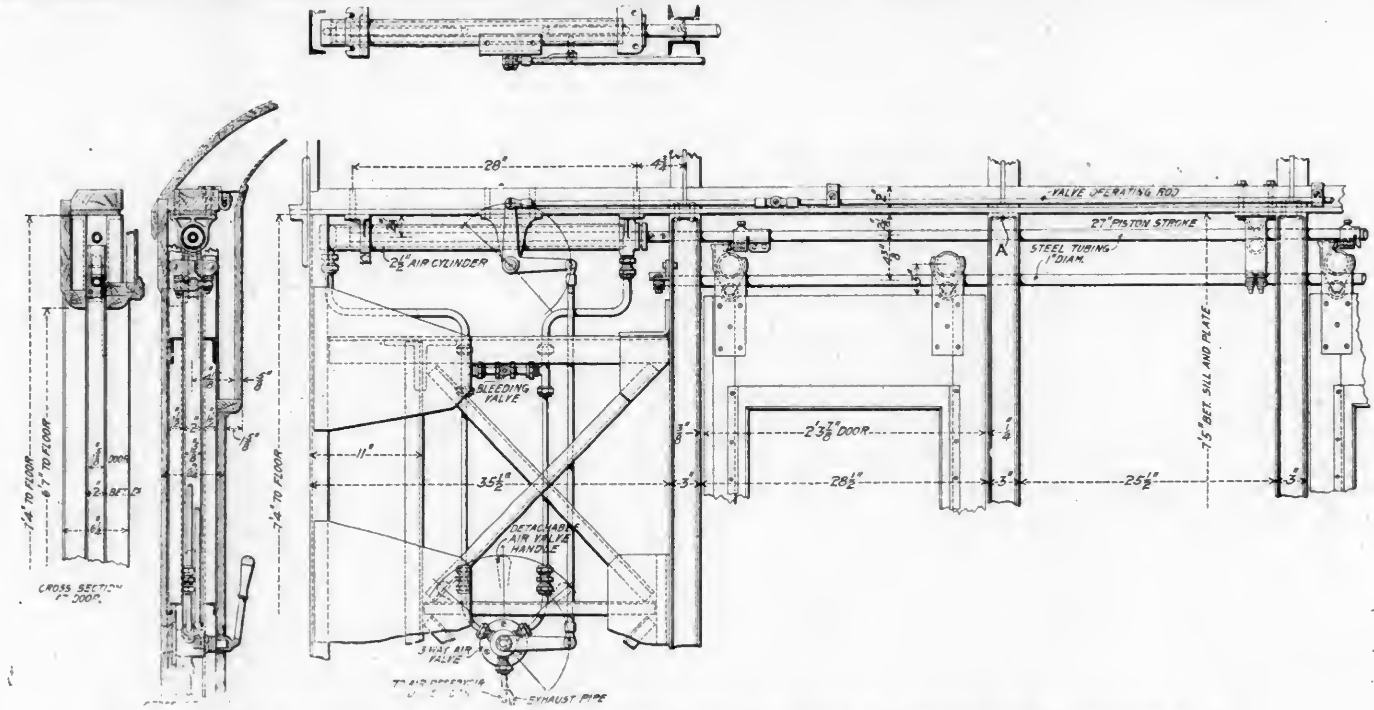
HALF LONGITUDINAL SECTION AND SIDE FRAMING.

HALF FLOOR PLAN AND FRAMING.

SECTIONS OF DOOR AND WINDOW FRAMING.

TRANSVERSE SECTIONS.

STEEL FRAME SIDE DOOR SUBURBAN CARS—ILLINOIS CENTRAL RAILROAD.

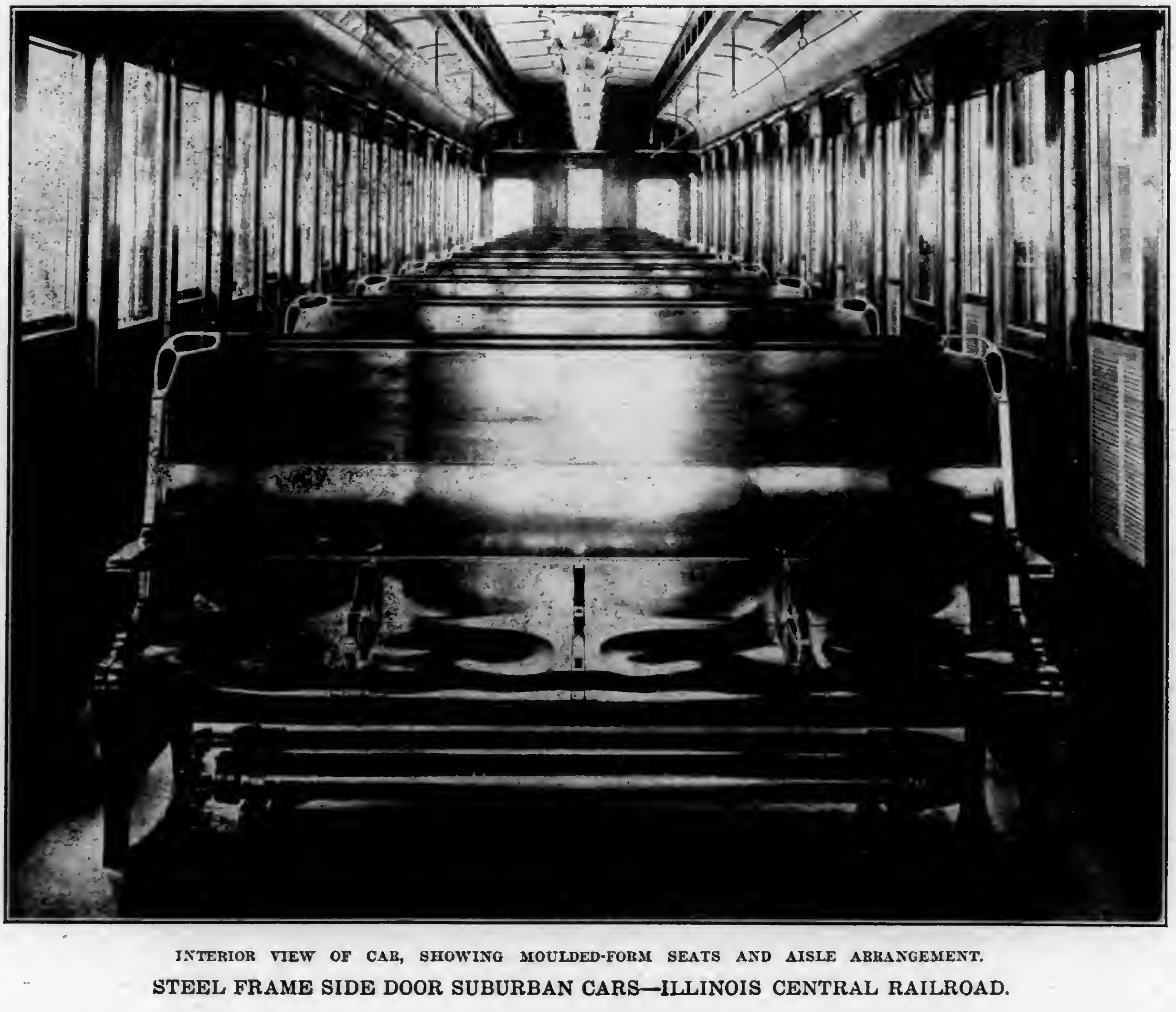


DETAILS OF DOOR OPERATING MECHANISM. (METHOD OF UPSETTING ENDS OF CHANNEL POSTS IS SHOWN AT A).

aisle 18 in. in width, extending the entire length of the car, connecting with the vestibule area and affording a passageway on both sides throughout the length of the train.

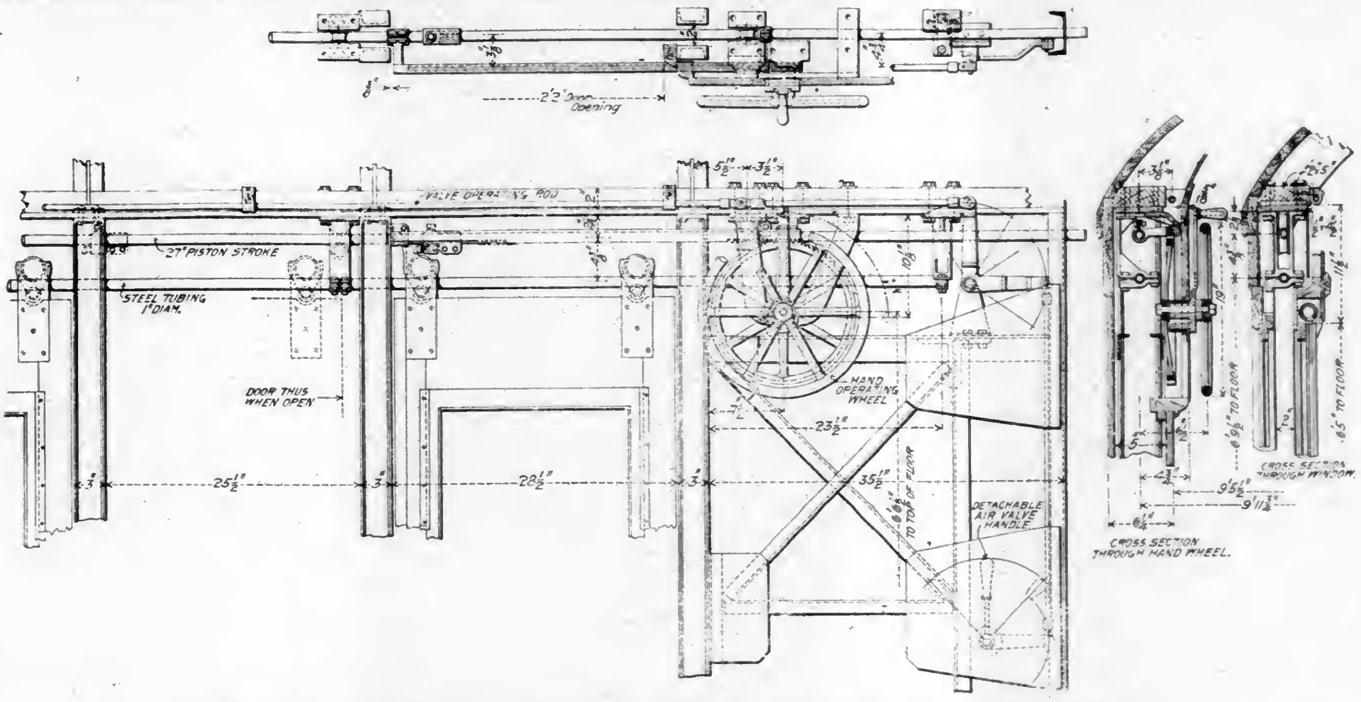
To give good light the glass is carried to a height of 6 ft. above the floor. These cars have the Pintsch light, with eleven three-burner lamps, making a total of 450 candle-power for each car. They are beautifully lighted and this is an object lesson in the illumination of suburban equipment.

These cars are carried on the I. C. R. R. Standard, four-wheel passenger equipment trucks, with 33 in. rolled steel wheels and 5 by 9 in. steel axles. They are equipped with Standard steel platforms and couplers, and the Sessions friction draft gear.



INTERIOR VIEW OF CAR, SHOWING MOULDED-FORM SEATS AND AISLE ARRANGEMENT.

STEEL FRAME SIDE DOOR SUBURBAN CARS—ILLINOIS CENTRAL RAILROAD.



DETAILS OF DOOR-OPERATING MECHANISM, SHOWING HAND-WHEEL AUXILIARY APPARATUS.

A novel method of attaching the draft rigging to the car has been adopted in consequence of the distance, 38 ins., between the center sills of the car. This consists of a steel plate, 2 ft. 5 ins. by 3 ft. 6 ins. by ¾ in., which is placed between the main sills of the underframe and the sub-sills of the platform and bolted through their flanges with twenty-four ⅝ in. bolts, accurately turned to reamed holes with a driving fit.

The weight of the car body is 61,400 lbs., and of the trucks 23,200 lbs., making a total of 84,600 for a seating capacity of 100 persons. Mr. Sullivan believes that this may be materially reduced without sacrificing strength.

In this system of construction the door operating devices constitute an element of vital importance. The accompanying illustrations show the entire operating mechanism, including the air cylinder for operating the doors at one end and the hand mechanism at the other end, for use whenever the supply of compressed air is cut off.

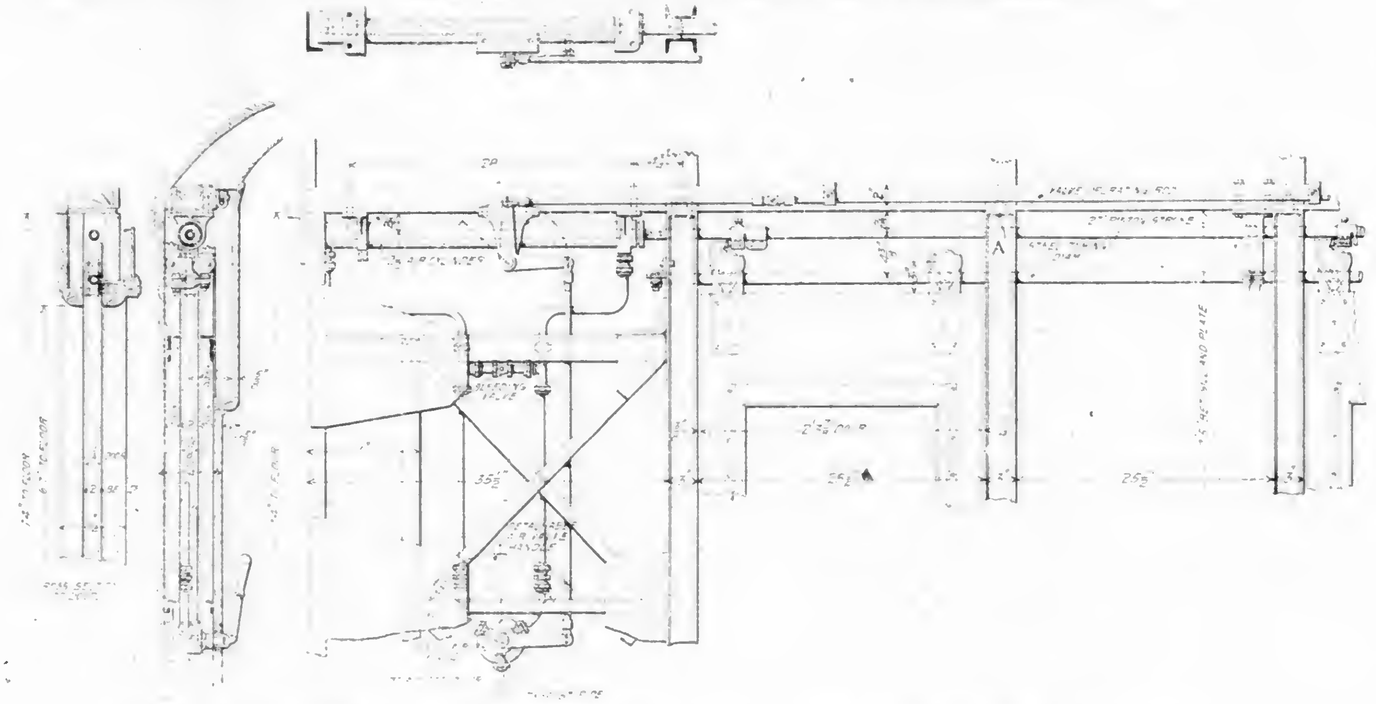
The air valve may be operated from either end of the car by means of the long valve operating rod shown on the drawing. This admits of the trainman working the doors from either end, which is quite a necessity with the method of having the collections made upon the train. The hand mechanism operates from one end of the car only, which is of less importance as it is but seldom used, the pneumatic apparatus working very successfully. The bleeding valve shown just below the air cylinder opens communication with the atmosphere from each end of the cylinder and equalizes the air pressure. The use of this valve is made necessary because in normal operation the full air pressure is against the piston either on the one side or the other, as the air pressure is relied upon to lock the doors by holding them tightly closed.

Whenever it may be necessary to cut out the air, the main air valve is placed on lap, which leaves one end of the cylinder containing air at full pressure, which will prevent the hand apparatus being used. This pressure is reduced by the exhaust of the bleeding valve and permits the piston to move freely in the cylinder when the hand apparatus is used. Each door cylinder is supplied from an auxiliary cylinder under the floor of the car, the pressure in which is maintained by a branch pipe from the train line in which is placed a check valve which closes automatically when the train line pressure is reduced in applying the brakes. The exhaust from the main air valve for operating the doors is carried through the floor of the car.

The different valve stems are flush with the interior finish of the car and present much the same appearance as the locks on the upper berths of a Pullman car. All of the door operating mechanism is contained within the walls and no part of it is visible to the passengers except the brass hand wheel and the lever which is used for throwing it into and out of gear, this being accomplished by a cam movement which requires a sweep of the lever of about 45 degrees. The clips on the piston rod which engage the door hangers and close the doors, are fitted with springs having a compression of about three-quarters of an inch. This spring movement equalizes any variation there may be in the setting of the clips, so that the cylinder pressure is distributed equally on all the doors.

The engraving shows the apparatus set for what is called its "permissive" operation, that is, the doors are closed and locked and held closed by air pressure with one movement of the piston, and released, but not opened by the other movement of the piston. This arrangement permits of any of the doors being opened by the passengers from either the inside or the outside of the car, and saves the necessity of opening all 12 doors at places where only one or two passengers may wish to enter or leave the car. This is the plan adopted for the winter season, and in the summer season, when there is no objection on account of weather conditions to opening as well as closing all of the doors at every stop, positive working is provided by merely mounting another clip on the piston rod immediately in front of the door hanger, so that the door is carried forward and back with each movement of the piston rod. Experience will determine which of these methods will be the more practicable.

The guide rollers for the piston rod are spaced five feet apart and mounted on roller bearings. The door hanger rollers are mounted on ball bearings. The piston rod, also tne roller which carries the door, are made of cold drawn steel tubing, perfectly smooth on the outside, and the rollers are accurately turned to fit the tube, so that there is very little friction and the doors work very smoothly. The doors are suspended from the upper rollers and hang free, being guided at the lower end by a groove in the threshold, which holds them in line. The piston rod is continuous, being about 64 feet in length and made of tubing in jointed sections of about 18 feet in length. The tubing used for the door rail is cut in lengths of five feet and mounted so that the rail of any door may be removed without interfering with the rails of the other doors. The door mechanism is complete for each side of the car, one side being a duplicate of the other, and they are operated independently of each other.



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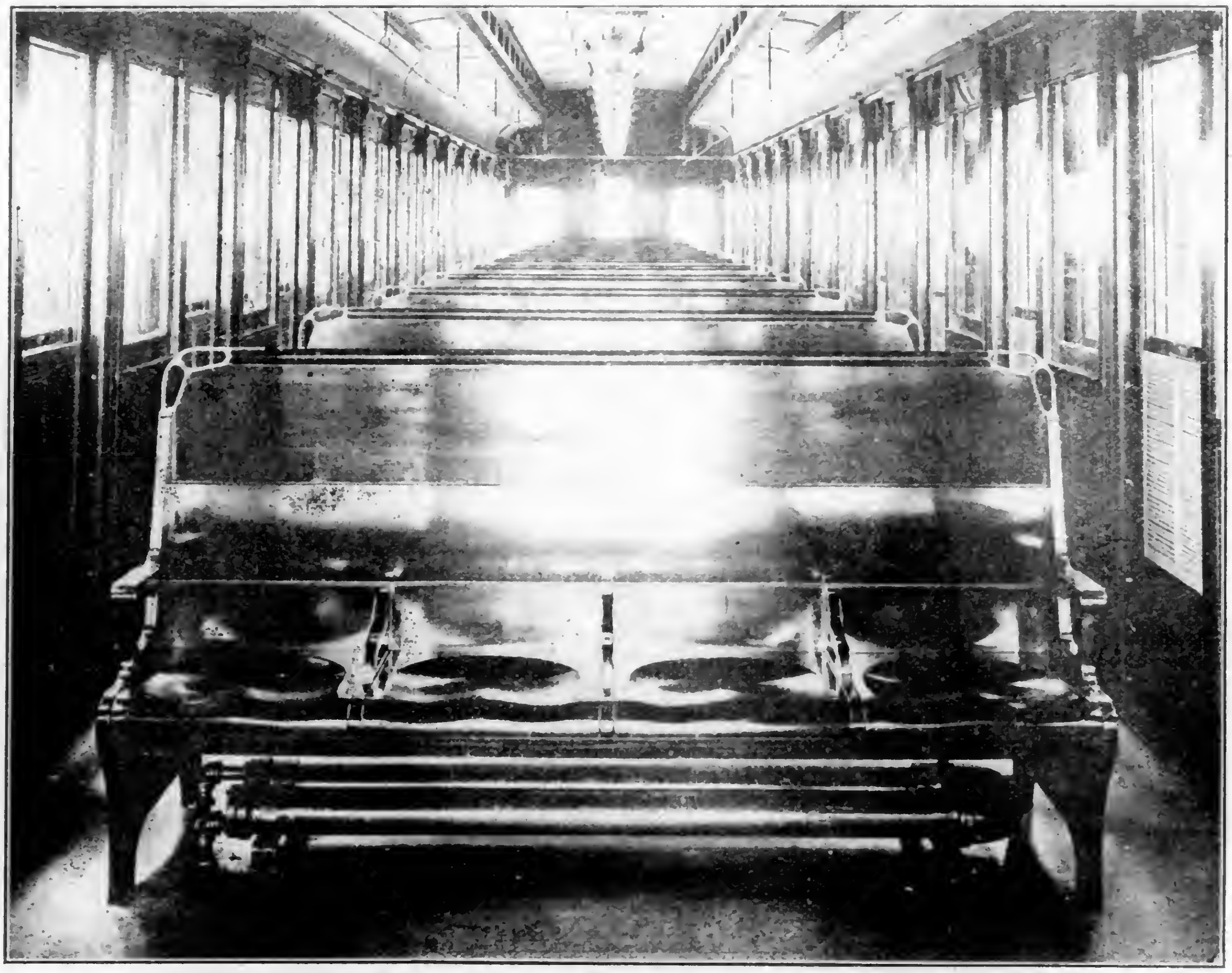

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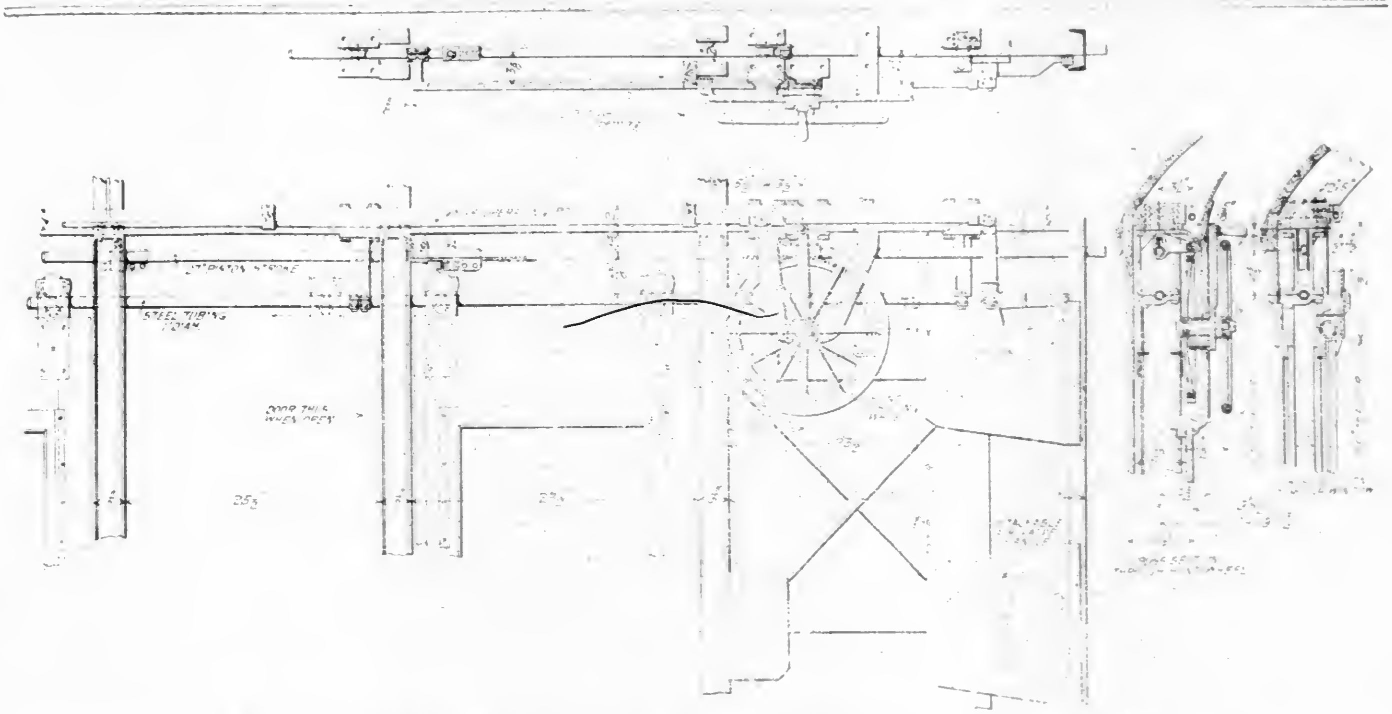
STEEL FRAME SIDE DOOR SUBURBAN CARS—ILLINOIS CENTRAL RAILROAD.



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NEW LOCOMOTIVE AND CAR SHOPS.

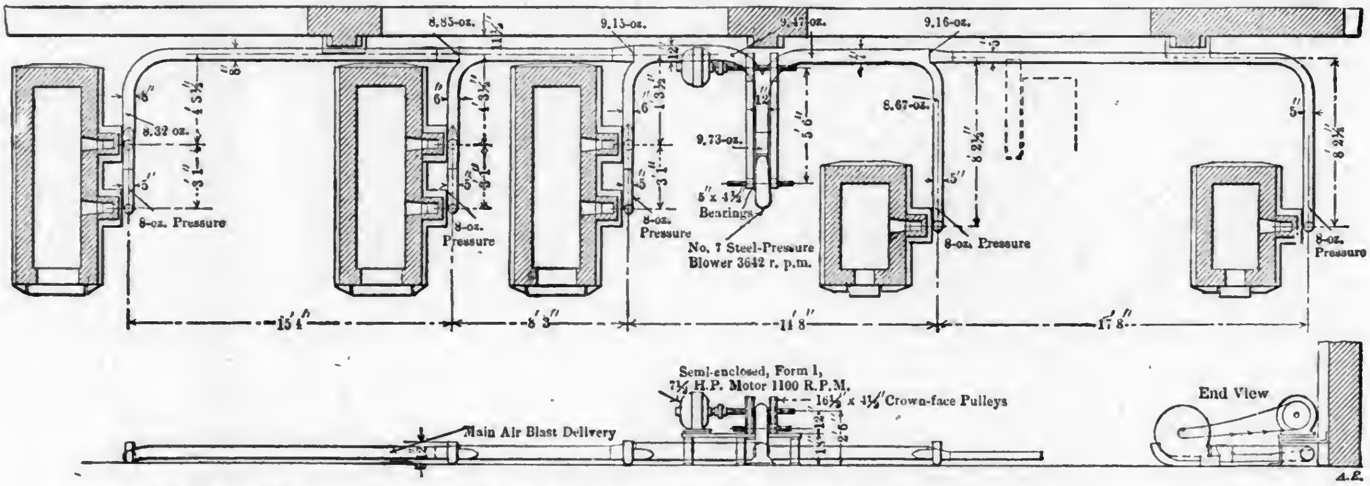
COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

XI.

PRESSURE-BLOWER SYSTEM FOR OIL FURNACES.—THE SCRAP PLATFORM.—A PNEUMATIC DRIVING-BOX CRANE.

In the description of the fuel oil furnaces in use at the Collinwood shops, presented in the previous issue, mention was made (see page 335, September, 1903, number) of the fact that each separated group of furnaces has an independent motor-driven pressure-blower outfit for supplying the 8 ozs. of air pressure that is required at the tuyeres of the Ferguson oil furnaces. Seven pressure-blower equipments were installed in the various buildings, so as to avoid the necessity of delivering the blast at long distances from the blowers and the excessive drops in pressure that would thus be incurred. In this article we present drawings to illustrate a typical pressure-blower system, which will also indicate the care that was taken in the designs to provide for the inevitable drops of pressure at elbows in the delivery pipe.



ARRANGEMENT OF THE MOTOR-DRIVEN PRESSURE BLOWER OUTFIT AND THE PIPING SUPPLYING AIR BLAST TO THE OIL FURNACES. BULLDOZER DEPARTMENT OF THE BLACKSMITH SHOP.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The air-blast system illustrated herewith is the one supplying blast for the forging furnaces at the south end of the blacksmith shop, which take care of the bulldozer work. As indicated in the engraving, five furnaces are here provided for, three large ones and two small, by a No. 7 American Blower Company steel pressure-blower, operated at 3,642 revolutions per minute. The air-blast delivery pipe runs from the fan through long-radius bends to the various furnaces, as shown, the fan being located as near a central point as possible. The sizes of the different sections of the pipe were carefully calculated so as to bring the resultant delivery pressures at the furnace tuyeres to the necessary 8 ozs. The blower, at the rated speed, delivers at a pressure of 9.73 ozs., the various drops in the different sections of pipe being indicated on the same in the engraving presented above.

The blower is driven by a 7½-h.p. Crocker-Wheeler constant-speed motor, operating at 1,100 revolutions per minute. A double-belt drive is used, one belt on each side of the blower. The motor and drive-pulleys are mounted upon a stand next to the wall, the details of which are of interest. The accompanying sketch at the right illustrates the construction of this stand, the position of the motor, pulleys and inverted hanger bearings being drawn in dotted lines superimposed upon the plan view. The stand is raised to permit the delivery pipe from the blower to pass underneath on its way along the wall. The arrangement of the stand, as well as of the blower and delivery pipe, is worthy of note for the economy of space effected thereby.

THE SCRAP PLATFORM.

The scrap platform at the Collinwood shops is a model for convenience and adaptability to local requirements, as well as the fuel oil system, described last month, is one of the most complete and best arranged plants for the purpose ever built. The design and equipment of these auxiliary departments were carried out by the officials in charge of the shop construction, to whom much credit is due for these details.

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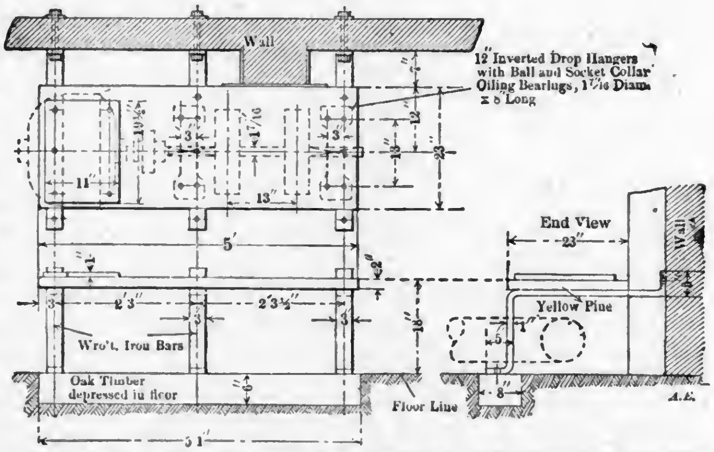

DETAILS OF SUPPORT FOR MOTOR DRIVING THE PRESSURE BLOWER.

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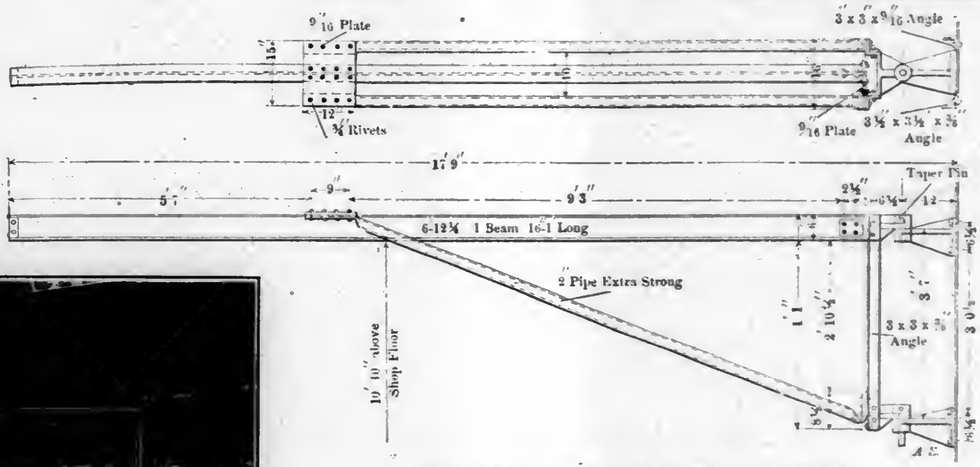
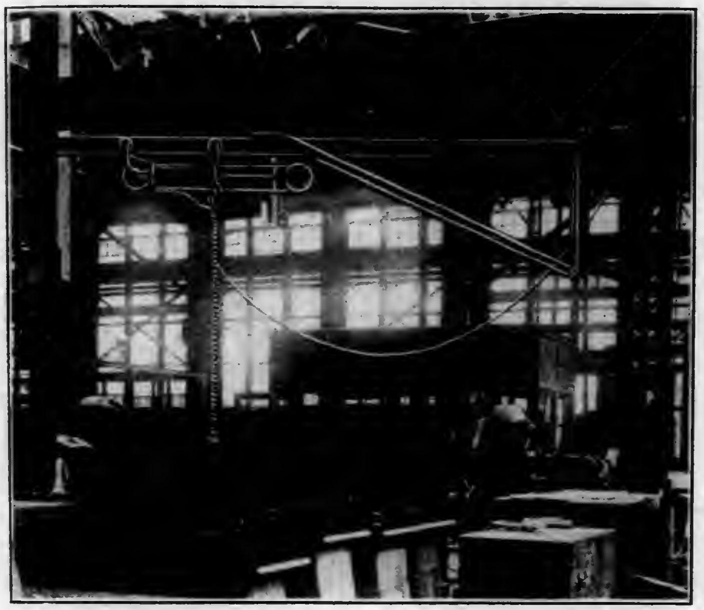


DETAILS OF CRANE FOR DRIVING BOX HOIST.



CRANE AND HOIST FOR DRIVING BOXES, IN THE DRIVING BOX SECTION OF THE LOCOMOTIVE SHOP. (See page 364.)

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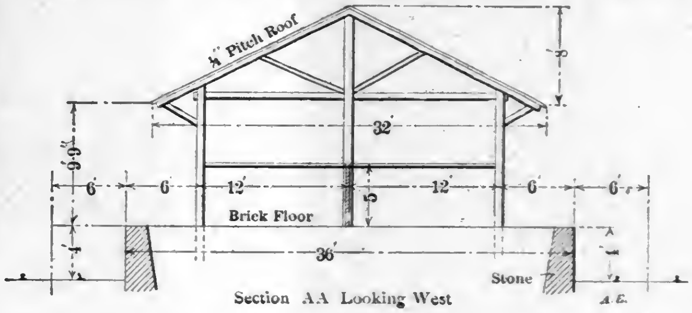
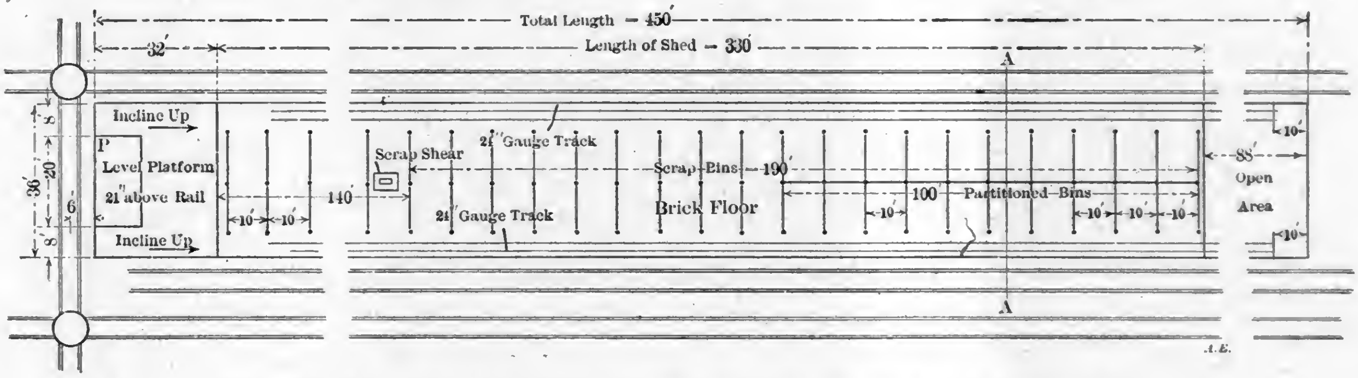


Section AA Looking West



PLAN AND CROSS SECTION OF SCRAP PLATFORM, SHOWING ARRANGEMENT OF SCRAP BINS.

VIEW OF WEST END OF SCRAP PLATFORM, SHOWING INCLINE LEADING DOWN TO GRADE LEVEL. (BRASS FOUNDRY STOREHOUSE AT THE LEFT.)

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

NEW LOCOMOTIVE AND CAR SHOPS.

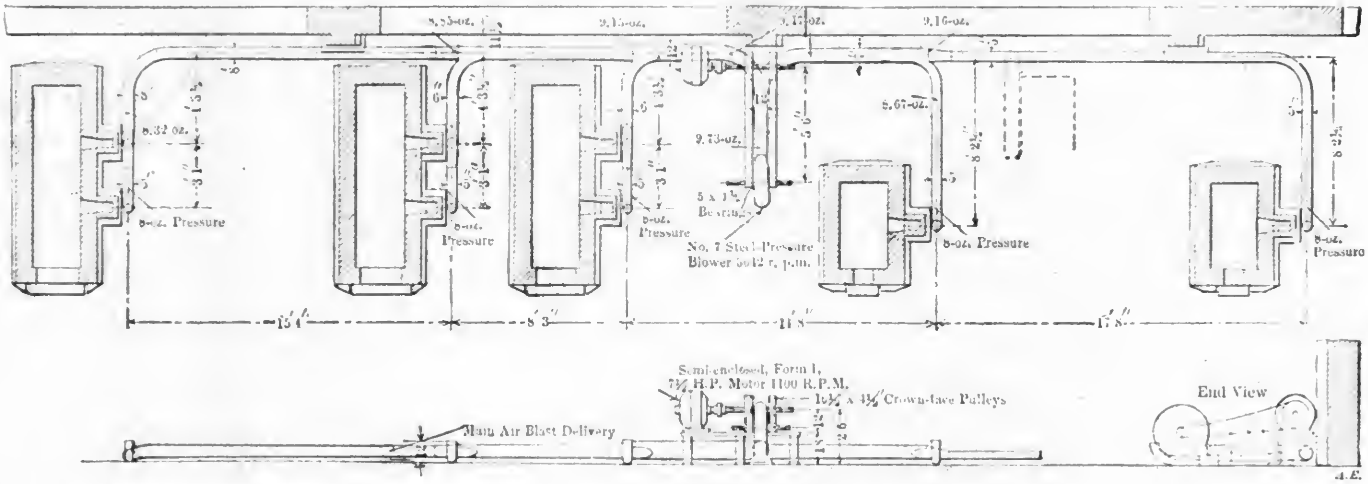
COLLINWOOD, OHIO.

Lake Shore & Michigan Southern Railway.

XI.

PRESSURE-BLOWER SYSTEM FOR OIL FURNACES.—THE SCRAP PLATFORM.—A PNEUMATIC DRIVING-BOX CRANE.

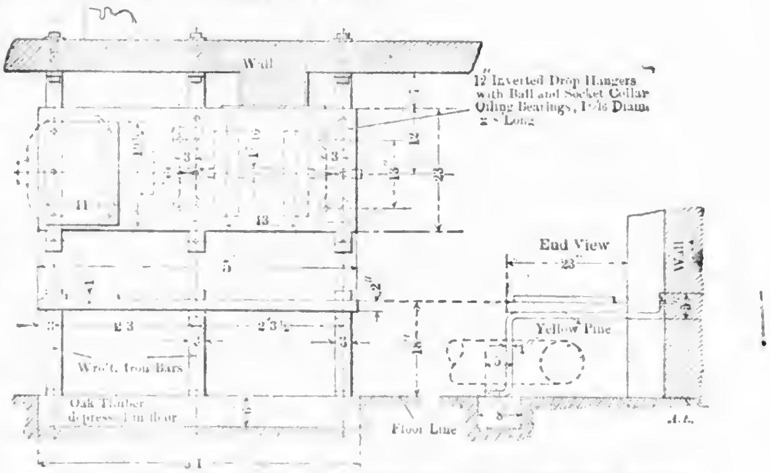
In the description of the fuel oil furnaces in use at the Collinwood shops, presented in the previous issue, mention was made (see page 335, September, 1903, number) of the fact that each separated group of furnaces has an independent motor-driven pressure-blower outfit for supplying the 8 ozs. of air pressure that is required at the tuyeres of the Ferguson oil furnaces. Seven pressure-blower equipments were installed in the various buildings, so as to avoid the necessity of delivering the blast at long distances from the blowers and the excessive drops in pressure that would thus be incurred. In this article we present drawings to illustrate a typical pressure-blower system, which will also indicate the care that was taken in the designs to provide for the inevitable drops of pressure at elbows in the delivery pipe.



ARRANGEMENT OF THE MOTOR-DRIVEN PRESSURE BLOWER OUTFIT AND THE PIPING SUPPLYING AIR BLAST TO THE OIL FURNACES. BULLDOZER DEPARTMENT OF THE BLACKSMITH SHOP.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The air-blast system illustrated herewith is the one supplying blast for the forging furnaces at the south end of the blacksmith shop, which take care of the bulldozer work. As indicated in the engraving, five furnaces are here provided for, three large ones and two small, by a No. 7 American Blower Company steel pressure-blower, operated at 3,642 revolutions per minute. The air-blast delivery pipe runs from the fan through long-radius bends to the various furnaces, as shown, the fan being located as near a central point as possible. The sizes of the different sections of the pipe were carefully calculated so as to bring the resultant delivery pressures at the furnace tuyeres to the necessary 8 ozs. The blower, at the rated speed, delivers at a pressure of 9.73 ozs., the various drops in the different sections of pipe being indicated on the same in the engraving presented above.

The blower is driven by a $7\frac{1}{2}$-h.p. Crocker-Wheeler constant-speed motor, operating at 1,100 revolutions per minute. A double-belt drive is used, one belt on each side of the blower. The motor and drive-pulleys are mounted upon a stand next to the wall, the details of which are of interest. The accompanying sketch at the right illustrates the construction of this stand, the position of the motor, pulleys and inverted hanger bearings being drawn in dotted lines superimposed upon the plan view. The stand is raised to permit the delivery pipe from the blower to pass underneath on its way along the wall. The arrangement of the stand, as well as of the blower and delivery pipe, is worthy of note for the economy of space effected thereby.



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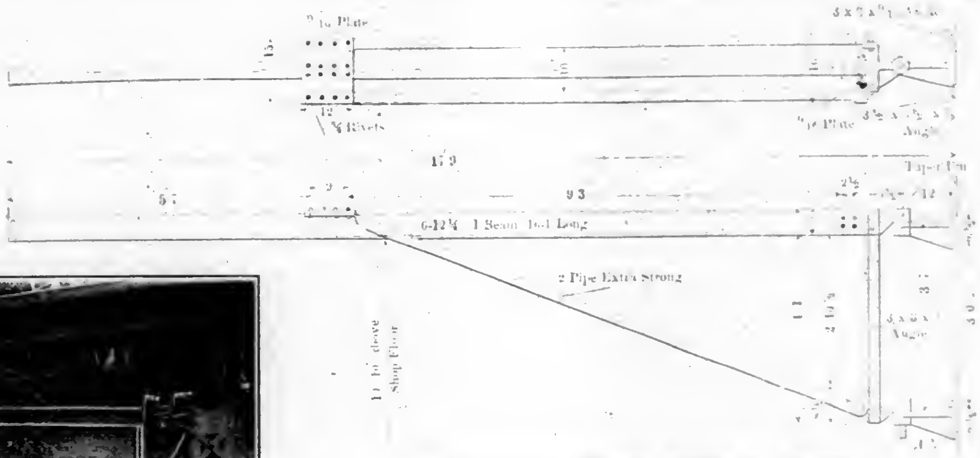
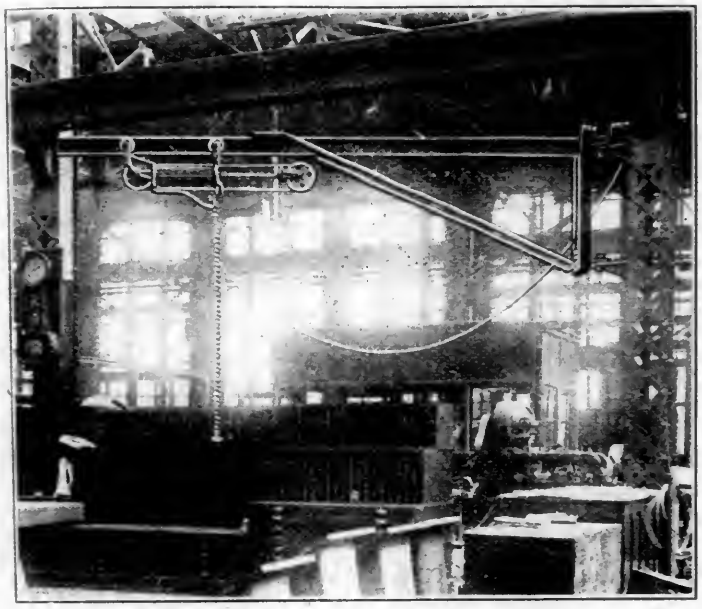
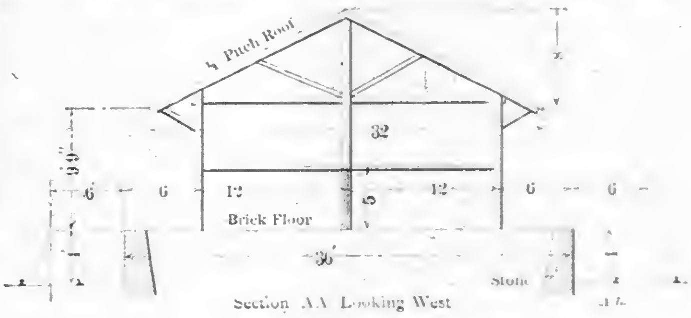
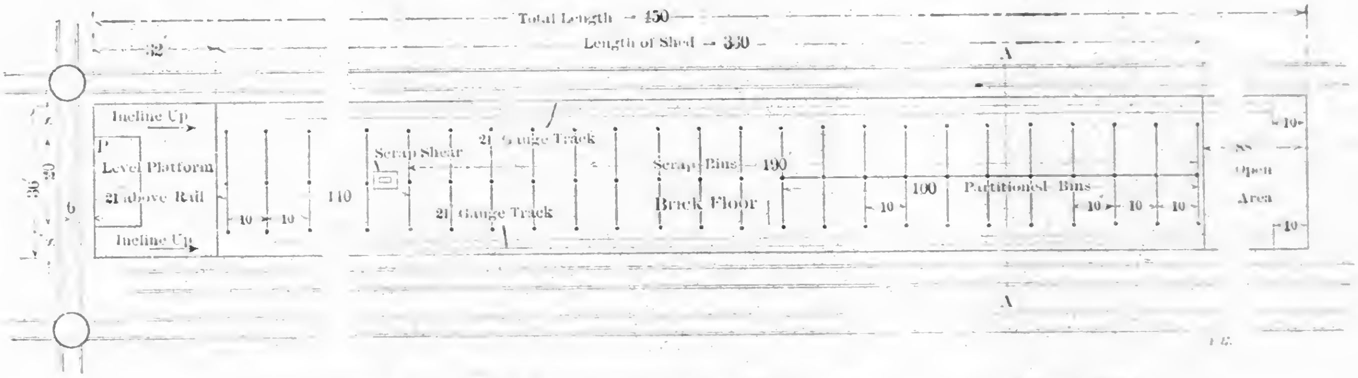


DETAILS OF CRANE FOR DRIVING BOX HOIST.



CRANE AND HOIST FOR DRIVING BOXES, IN THE DRIVING BOX SECTION OF THE LOCOMOTIVE SHOP. (See page 364.)





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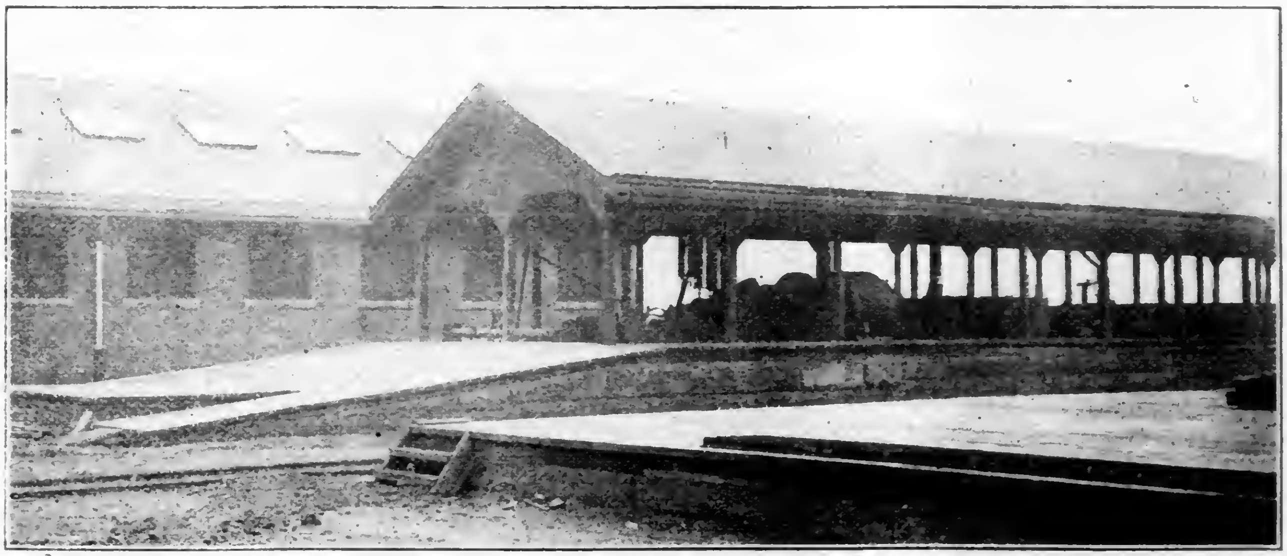


VIEW OF WEST END OF SCRAP PLATFORM, SHOWING INCLINE LEADING DOWN TO GRADE LEVEL. (BRASS FOUNDRY STOREHOUSE AT THE LEFT.)

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY

transferring or delivery to the blacksmith or bolt shops. The scrap shear and bolt straightener will be located near the bins at the point where the wrought-iron scrap will be sorted. From this point bolts and scrap for piling will go to the west end of the platform and the other scrap to the bins.

To the south of the scrap platform is situated the iron storehouse, in which all iron is stored for the blacksmith and bolt shops. Also all finished forgings and the brasses are to be stored there.

CRANE AND HOIST FOR DRIVING BOXES.

Two light portable cranes with a lifting capacity each of 700 lbs. have been fitted up for driving-box work in the locomotive shop at the Collinwood shops. These cranes have Curtis air hoists and are arranged so that they may be carried by the shop traveling crane to any of the main columns of the building, which are fitted with the brackets to receive them. These brackets are secured to the columns wherever driving-box work is done, and the air hoist is supplied with air by a swinging hose. This is an inexpensive "kink" which saves a large amount of labor. It represents an important principle in shop equipment in that the use of large overhead traveling cranes does not avoid the necessity of providing light pillar cranes for individual machines or departments.

LOCOMOTIVE FOR SUBURBAN SERVICE.—PHILADELPHIA & READING RAILWAY.

S. F. PRINCE, SUPERINTENDENT MOTIVE POWER. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

SIX-COUPLED SUBURBAN LOCOMOTIVE.

PHILADELPHIA & READING RAILWAY.

Six suburban locomotives, for service into Philadelphia, have been completed for the Philadelphia & Reading Railway by the Baldwin Locomotive Works. They are of the double-end type and are in use on the Germantown & Chestnut Hill branch and on the Norristown branch between Manayunk and the Philadelphia terminal. The arrangement of the driving and truck wheels is like that of the New York Central suburban locomotive illustrated in this journal in April, 1902, page 115, but the Philadelphia & Reading engine has a four-wheel instead of a six-wheel truck under the rear end. These engines are fitted with slide valves. They have wide grates for anthracite coal of buckwheat size. A noteworthy feature of the boiler is in the very short tubes, 9 ft. in length. These engines will exert a tractive effort of 26,600 lbs. and should start trains very quickly. The cab of this engine is placed sufficiently far back on the firebox to bring the engineer and fireman together in the same compartment. A comparison of the principal features of this design and the two recent examples of locomotives for similar service on the New York Central and the Central Railroad of New Jersey, as given in the following table, may be convenient for reference:

THREE RECENT SUBURBAN LOCOMOTIVES.

Name of railroad	N. Y. C.	C.R.R. of N.J.	P. & R.
Number of road or class	1410	200	381
Builder	American	Baldwin	Baldwin
Simple or compound	Simple	Simple	Simple
When built	1902	1902	1903
Weight, engine total, lbs.	216,000	189,900	201,700
Weight on drivers, lbs.	128,000	129,000	120,860
Weight on leading truck, lbs.	......	21,900	19,120
Weight on trailing truck, lbs.	......	39,000	61,920
Weight of tender (loaded), lbs.	......	Side tank	......
Wheel base, driving, ft. and ins.	15-0	14-0	12-6
Wheel base, total, ft. and ins.	35-9	31-8	30-9
Driving wheels, diameter, ins.	63	63	61⅝
Cylinders, diameter, ins.	20	18	20
Cylinders, stroke, ins.	24	26	24
Heating surface, firebox, sq. ft.	162	96.6	156.3
Heating sur., arch tubes, sq. ft.	......	43.0	......
Heating surface, tubes, sq. ft.	2,275	1,695.0	1 825.5
Heating surface, total, sq. ft.	2,437	1,834.6	1,981.8
Firebox, length, ins.	93	109	94
Firebox, width, ins.	97⅞	72	105
Grate area, sq. ft.	62.1	54.5	68.5
Boiler, smallest diameter of, ins.	70	60	66
Tubes, No. and diameter in ins.	365-2	249-2	447-0
Tubes, length, ft. and ins.	12-0	13-0	9-0
Steam pressure, lbs., per sq. in.	200	200	200
Reference in American Engineer and Railroad Journal	April 1902 P. 115	June, 1902 P. 200	Oct., 1903

The following tables give the ratios and a record of the leading dimensions of the Philadelphia & Reading design:

Heating surface to cylinder volume	= 226
Tractive weight to heating surface	= 61.
Tractive weight to tractive effort	= 4.54
Tractive effort to heating surface	= 13.43
Tractive effort x diameter of drivers to heating surface	= 824.
Heating surface to tractive effort	= 7.4%
Total weight to heating surface	= 101.8

SIX-COUPLED SUBURBAN LOCOMOTIVE.

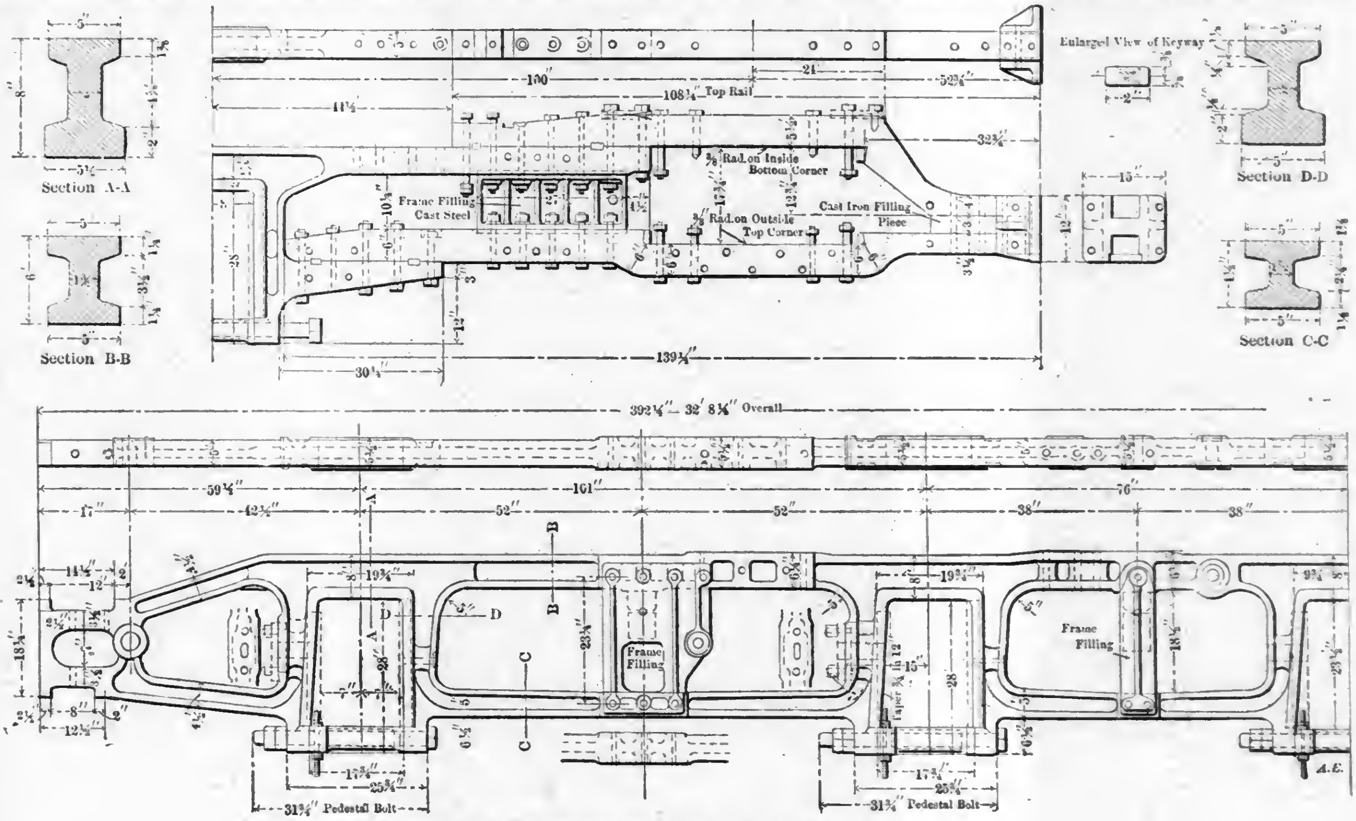
PHILADELPHIA & READING RAILWAY.

Gauge	4 ft. 8½ ins.
Cylinder	20 x 24 ins.
Valve	Balanced
Boiler—Type	Wagon top
Diameter	66 ins.
Thickness of sheets	11-16 and ¾ in.
Working pressure	200 lbs.
Fuel	Anthracite buckwheat
Staying	Radial
Firebox—Material	Steel
Length	94 ins.
Width	105 ins.
Depth	Front, 59¼ ins.; back, 46¾ ins.
Thickness of sheets	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.
Water space	Front, 3½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes—Material	Iron
Wire gauge	10 B. W. G.
Number	447
Diameter	1¾ ins.
Length	9 ft. 0 in.
Heating Surface—Firebox	156.3 sq. ft.
Tubes	1,825.5 sq. ft.
Total	1,981.8 sq. ft.
Grate area	68.5 sq. ft.
Driving Wheels—Diameter outside	61⅝ ins.
Diameter of center	54⅝ ins.
Journals	8½ x 12 ins.
Engine Truck Wheels (front)—Diameter	30 ins.
Journals	6 x 12 ins.
Engine Truck Wheels (back)—Diameter	33 ins.
Journals	6 x 12 ins.
Wheel Base—Driving	12 ft. 6 ins.
Rigid	12 ft. 6 ins.
Total engine	30 ft. 9 ins.
Weight—On driving wheels	120,860 lbs.
On truck, front	19,120 lbs.
On truck, back	61,920 lbs.
Total engine	201,700 lbs.
Tank—Capacity	3,000 gals.
Coal	7,500 lbs.

CAST STEEL LOCOMOTIVE FRAMES.

DELAWARE & HUDSON COMPANY.

As a result of careful study of the failures of locomotive frames, Mr. J. R. Slack, superintendent of motive power, and Mr. G. S. Edmonds, mechanical engineer, of the Delaware & Hudson Company, have developed new designs with special reference to the action of cast steel in the foundry. Instead of casting frames of the form of wrought iron with rectangular sections throughout, this design distributes the metal in I sections, with curves of large radius as fillets, and the members are also tapered and the thickness of the webs are varied wherever this seems to offer advantages. The particular frame illustrated in this engraving is that of the 4—6—0 type locomotive illustrated on page 285 of the August number of this journal. This design represents the latest and most satisfactory development of this principle on this road, and it is reasonable to expect improved service from a careful distribution of the metal. Mr. Edmonds has recently read a paper on the subject of locomotive frames before the Pacific Coast Railway Club, which is interesting in this connection.



CAST STEEL FRAMES FOR 4—6—0 TYPE LOCOMOTIVE.
DELAWARE & HUDSON COMPANY.

It is evident to those who have devoted the greatest amount of study to the subject of frame failures that not only must the design of the frames be correct in detail, but that the frame structure as a whole may need bracing in a new way in order to prevent the deflections which result in breakage. The combination of correct design with the necessary bracing should result in a very greatly needed improvement. The results of some interesting experiments upon the deflections in locomotive frames will soon be recorded in this journal.

A RATIONAL METHOD OF DESIGNING LOCOMOTIVE FRAMES.

From the paper by Mr. Edmonds the following paragraphs are abstracted:

One thousand pounds unnecessary weight in a pair of engine frames, on a road with 1,000 engines, same making 50,000 mileage per year, in life of said engines, assuming 15 years, means 375,000,000 tons hauled one mile. This, at the arbitrary figure of $.0002 as maintenance and transportation cost of one ton one mile, gives $75,000, since we can assign, assuming 1,500 as train tonnage, five of these engines, for one entire year, to the movement of this extra frame load.

For material, hammered iron has the favor of the majority, excepting in cases of very heavy forgings, where cast steel is employed. Usually the section used is the same, whether of iron or steel. This may be accounted for by the commendable spirit of standardization prevalent at this period, but just why the same line of reasoning should hold with new design is not as apparent.

While experimental with some, other roads have used cast steel to a considerable extent, with variable experience.

Compared we note:

1. Hammered iron has the distinctive advantage of being readily welded. Investigation as to results with steel finds some things to be desired. This may in part be accounted for by lack of tools of sufficient power, the constituents of material being such as to note permit of its being reduced to as plastic a condition as the iron, requiring a considerably greater force to unite.

2. Uncertainty of product meets claims on both sides, for, while with steel, blowholes and honeycombing will creep in, ofttimes being hidden in the heart of the section, equally true, from time to time, with the large amount of steel now being used in locomotive and car construction, the difficulty of confining scrap to wrought iron cannot but increase. Failures in many instances are correctly attributable to these sources.

3. In design, with hammered iron, we are practically limited to the rectangular section, whereas with cast steel it may be molded to meet the most exacting conditions.

In these days, with the demand for greater power in proportion to weight, the doing away with the dead load and transferring its equivalent parts where it may be of value, viz., boilers and cylinders, this feature points to a more extended use of material in the future.

Raised bosses at parts which need to be finished reduce this portion of the cost a considerable extent, such being applicable to all designs in steel, irrespective of the section. If, as is believed by some, the outer unfinished section of a steel casting is stronger than the interior, a sub-advantage is also secured.

Analyzing, we know that:

1. A web section gives us higher moments of inertia per unit weight than any other.

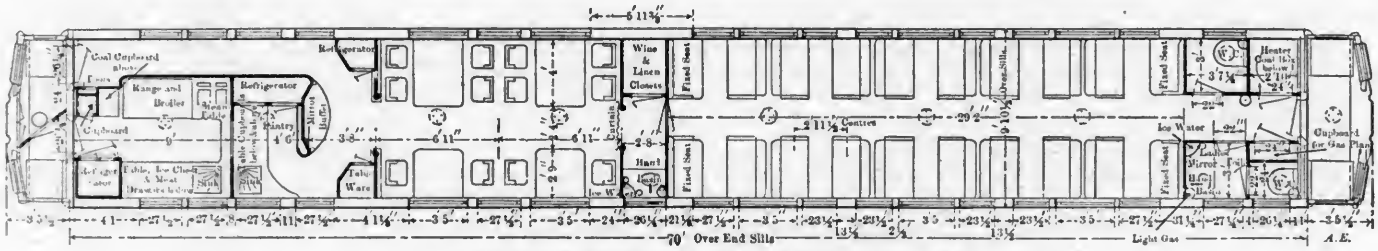
2. A frame casting is such that the use of coring must be eliminated, else first cost will be excessive, with possibilities of shifted cores.

3. The second condition reduces the number of available web

sections to channel and I sections. When we consider the problem of molding, with shrinkage effects, the latter seems decidedly the more desirable of the two. The comparative thinness of the I casting allows of a ready and careful examination by the inspector, whereas with the rectangular section, ofttimes the outer surface covers a multitude of sins, discovered only when failure of part discloses interior honeycombing. Hence, while of higher factor of safety if sound, the uncertainty of the material, for above reason, favors the I section.

Lack of time prevents a more exhaustive treatise of the subject, which many others could treat to better advantage than the writer, yet, while limited in its scope, four ends are sought, the accomplishment of which marks the attainment of the purpose of the paper, viz.:

1. The advancement of the design of the locomotive as made by a rational method of frame design.
2. The presentation of the necessity for more than one set of specifications to govern the cast steel as used on the locomotive and tender.
3. The adoption, if possible, of standard sets of specifications for cast steel on all roads, reducing the problem of production to the manufacturer to a minimum.
4. Awakening of a discussion as to whether or no we do well in adhering to the rectangular section, or will the more exacting conditions soon to be met mark its passing to some other form?



COMBINATION DINING CAR AND FIRST-CLASS COACH.
CANADIAN NORTHERN RAILWAY.

COMBINATION DINING CAR AND COACH.

CANADIAN NORTHERN RAILWAY.

Through the courtesy of the mechanical officers of this road a floor plan of one of their new combination dining cars has been received. In a 70-ft. car, besides seating accommodations for 40 persons in the coach seats, room is found for 12 table seats, a 9-ft. kitchen and a 4-ft. 6-in. pantry. These cars were designed to run west of Winnipeg, where the country is sparsely settled and yet where dining-car service is required. By means of these cars an extra coach on a train and the expense of large and heavy dining cars are saved. The drawing shows the disposition of the floor space.

THE PROPORTIONS OF MODERN LOCOMOTIVES.

Those who are interested in the development of the American locomotive should procure copies of the paper read last month before the New York Railroad Club by Mr. L. H. Fry. It records a painstaking comparison of over 250 locomotives with respect to the factors of adhesion, steam consumption, combustion conditions and efficiency of design. Mr. Fry has placed before the club the complete record of his work in this connection, which was concisely summarized in his article in this journal last June. From this paper the tendencies in modern design may be intelligently studied.

While it is impossible to draw definite conclusions from averages derived from individual locomotives between which wide variations exist, the classification used in the tables permits of more valuable comparisons than were possible before.

Mr. Fry, in discussing his "BD" method of comparing locomotives by the ratio of tractive effort multiplied by the diameter of driving wheels and divided by the heating surface (described in his article in this journal in October, 1902, page 313), says: "The objection may be made to the use of a factor of this sort that it does not take any account of the relative value of heating surface. A well designed boiler may, under similar conditions, be capable of evaporating considerably more water per square foot of heating surface than can a poorly designed boiler." This at once raises the question, "What constitutes a well designed boiler?" This is one of the most important questions of locomotive practice to-day.

There seems to be a very great difference in effectiveness of heating surface in different locomotives. For example, two well-known passenger locomotives in Mr. Fry's list which are of the same type, of almost the same total weight, and in apparently similar service, have not by any means the same heating surface. In fact one has 33 per cent. more than the other. Both steam freely and both do good work. These two locomotives represent entirely different ideas in design. One stands for a selection of an amount of heating surface which will fit the other factors of design in accordance with ratios or relationships which have been found satisfactory in previous classes of engines. The other locomotive stands for the maximum heating surface which could be provided. This shows a difference of opinion which seems remarkable. For several years the good work done by foreign locomotives, especially French, with heating surfaces much smaller than ours, has caused comment. It is unquestionably true that a boiler cannot have too much heating surface, providing it is all effective, but there is reason to raise the question whether free circulation has not in many cases been sacrificed in order to secure large surfaces. Where to draw the line between circulation and heating surface is a nice question and one which is now being earnestly studied by those who are having the most trouble with boilers. It is to be hoped that the trial of a French locomotive, soon to be carried out in this country, will throw some light on this subject.

While the averages drawn by Mr. Fry show rather uniform general tendencies, such individual differences as those mentioned stand out prominently enough to indicate that a great deal yet remains to be learned with reference to boiler proportions. The figures in the paper referred to should be plotted and the locomotives representing the high and low points in the curves should be compared as to performance. Road tests of a half-dozen passenger and perhaps a less number of freight engines, under suitable and similar conditions, could be made without great expense. It seems strange that some big railroad does not undertake to learn the facts which are so greatly needed.

There is a rapidly growing sentiment in favor of the use of alternating-current apparatus for the electrical equipment of railroad repair shops, as this type has many valid claims over direct-current apparatus, and the rapid introduction of practical mechanical variable speed mechanism or the use of magnetic clutch speed changes makes the induction motor as flexible and available for variable speed as the direct current motor. The principal advantage of the alternating-current system is the high working voltage possible, and corresponding economy in weight of wire, with long distances. The electric requirements of most railroads in their new power stations for shops involve electric lighting for distant stations and yards, and a high voltage is necessary under such conditions.—L. R. Pomeroy.

COMPARISON OF HEADLIGHTS: OIL, ACETYLENE AND ELECTRIC.

The following figures and statement were presented by Mr. Wm. McIntosh in a topical discussion before the recent convention of the Master Mechanics' Association.

It appears that of the 41,300 locomotives in the United States, fully 37,450 still retain the oil lamp and ordinary planished reflector for headlights. About 3,200 have electric headlights, using the ordinary reflector, and generating electricity with small steam motors of the reciprocating or turbine type—the latter rapidly coming into favor.

There are some 1,650 acetylene generators now in use for generating gas for locomotive headlights, which are usually equipped with the regulation sheet iron case and planished reflector, the remainder with what is known as the "Lens Mirror" or "Searchlight Reflector," which is much smaller than the planished reflector, and vastly more powerful and reliable, occupying a much smaller casing, which is usually formed cylindrically, and therefore, much more compact and durable. The reflector itself being of glass, and practically indestructible, requires only occasional wiping off to be in condition for service indefinitely. It would seem probable that witn these advantages it should soon succeed the old type of lamp.

The old oil lamp when compared with the new types of acetylene and electric headlights, cost much less for its supply of oil than the others do for carbide or steam, yet when the costs of operating it are counted carefully, including cleaning material, wicks, chimneys, and burners, with the frequent losses from burning up, does not prove to be so economical after all; and it falls far behind in the candle power of either acetylene or electricity, and failing also in reliability.

Acetylene gas, while costing more for its carbide than oil, does not require chimneys, nor expensive burners with wicks, and gives out several times the candle power of the best type of oil burning headlight, without bringing out criticism of its intensity.

The electric headlight is more expensive in the line of first cost; also in maintenance, owing to the motor and dynamo required to generate the current, and the amount of steam needed to operate it. The intensity of the light thrown out is objected to by some on account of the glaring properties, and tendency to affect the vision of engineer's approaching it; while others claim that these features are not seriously objectionable, and the advantages far outweight them.

Below are presented some data regarding cost of maintaining the oil lamp in comparison with the electric and acetylene lights.

One road reports the cost of maintaining 450 engines with ordinary headlights for a period of one year as follows:

Name of Parts.	Number of Parts.	Total Cost.	Average Cost per Engine.
New headlights, complete	63	$1,249.50	$2.76 +
New interiors	36	408.00	.91
New burners	138	293.70	.65
New cases	6	7.00	.02 —
Reflectors replated and required	268	815.54	1.81 +
Buttons and other small repair parts	...	55.00	.12 +
Chimneys	6,396	533.00	1.18
Wicks	1,056	21.56	.05
Glasses	204	91.71	.20 +
Cleaner (boxes)	1,074	208.80	.46 +
Labor and material, repairs	...	286.66	.64
Grand total	...	$3,970.47	$8.82

The above road reports the comparative cost of operating oil and acetylene lights so far as the light producing medium is concerned as follows:

With kerosene oil, at 7¾ cts. per gallon in tank lots, and with carbide at 3¼ cts. per pound in 100-lb. lots:
Cost of oil light per hour....33-100 cts.
Cost of acetylene light per hour....58-100 cts.

In presenting this statement it was suggested that a considerable saving could be effected by substituting the acetylene for the oil headlight, because of the possibility of eliminating a number of extras, not required with acetylene, but, used in connection with oil lights, as follows:

Replating reflectors	$815.54
Buttons and other small parts	55.00
Chimneys	533.00
Wicks	21.56
Cleaner	208.80
Total	$1,633.90

Another road reports tests covering oil, acetylene, and three different types of electric headlights as shown in the total below:

With cost of kerosene 14½ cts. per gallon, and with cost of carbide 5 cts. per pound:

Kind of Light.	Cost per 1,000 Engine Miles.	Relative Value of Light.
Coal oil	.1844 cts.	1
Acetylene	.4688 cts.	8
First—electric	.2821 cts.	50
Second—electric	.7109 cts.	50
Third—electric	.2533 cts.	50

This comparison is made on the basis of 16 hours light per 1,000 engine miles.

In summing up, it is apparent that the oil burning headlight has had its day, and must give way to better devices. It is an awkward affair at best, with its large housing shaking loose, and front glass that is often breaking; its abnormal capacity for using up chimneys, and wicks; the frequency of replenishing the reflector; the number of leaks that occur in its attached oil reservoir and connections; the fires that often develop, resulting in the burning up of the entire apparatus, and the care required, in the way of trimming and cleaning—these all combine to add to its unpopularity.

In former days when every locomotive, like Goldsmith's rood, maintained its man, or regular engineer, the oil lamp received the care and attention required to keep it in serviceable condition; but in these days of pooling and double crews, it is neglected, and generally presents a dilapidated appearance. It will be claimed, and truly, that the acetylene and electric lamps also require attention and renewals; but if supplied with "lens mirror reflectors," of the regulation diameter, and correspondingly small housings, which can be constructed on cylindrical lines, and largely of malleable or cast iron, furnishing the rigidity and endurance required, much better results should be obtained. The relative cost of the different types of headlights might be approximated at $25 for the oil lamp, $100 for acetylene, and $200 for the electric. And careful records will show, that but little, if any, economy will follow the use of the oil lamp, while the efficiency is largely in favor of electric or acetylene.

INTERNAL COMBUSTION ENGINES.

Confidence in gas engines is constantly increasing. Ten years or so ago the writer witnessed a test wherein the makers of the engine were called in order to insure the operation of the machine for a sufficient time to permit of taking the desired number of indicator cards. Now we may point to the fact that the City of Philadelphia is to rely entirely upon gas engines for the purpose of a new emergency fire system for the business district of the city. In England continuous runs of 138 days have been made by a gas engine without stopping.

In his paper on internal combustion engines read before the Master Mechanics' Association, Mr. Sanderson expressed the opinion that if the gas engine had begun its development before the steam engine, the latter would not have been developed at all. He is probably safe in this statement, for the gas engine has now attained an efficiency of operation which is higher than the theoretically perfect performance of steam.

The introduction of the subject before the Master Mechanics' Association is timely, and one does not need to be an enthusiast to clearly see the necessity for closely watching this remarkable progress. Leaving out of account the possible future application of the internal combustion engine to direct transportation, it has a sufficient field in other lines connected with railroad work now that the electric generator has become a necessity.

It would be a pity if the woeful loss of life in the recent Paris-Madrid motor car race should leave no trace of useful effect. From that fool-hardy performance may be seen the

possibility of running a 70-h. p. motor car a distance of 342 miles, over ordinary public roads, in 5 hours 13 minutes, on an average speed of about 66 miles per hour, which is the average schedule speed of the "Atlantic City Flier," for a distance of 55 miles. That this can be accomplished with these machines entitles the principle which they represent to attention as a possible factor in heavier transportation service. Speeds close to 90 miles per hour are already recorded for motor cars. Some recent ones have been equipped with motors of 110 h. p. In the race referred to, an ordinary touring car made the run of 342 miles at an average speed of 38 miles per hour, when fully loaded with passengers.

Without venturing a prediction in this connection the facts mentioned sufficiently justify the conclusion that the internal combustion engine is sure to occupy a place which cannot be filled by the steam engine.

In the matter of shop-power plants, especially where forging work is to be done, the time has arrived for considering gas producers and gas engines.

METALLIC PACKING.

Motive power officers who are not having trouble with piston rod and valve stem packings are exceptional. Packing is blowing, literally from one end of the country to the other, and the situation has become serious when wrecks occur because the leakage of steam obscures the view of engineers. It is expensive to renew metallic packing on a locomotive 20 times in 60 days, but this is being done. It is even impossible for these officers to fully appreciate how this subject is neglected by their own people and will not credit it until they are forcibly brought in contact with it. A little systematic care will save thousands of dollars in wear on piston rods, valve stems and packing rings. It is no more trouble to keep piston rods and valve stems steam tight than many other parts of the engine, yet they seem to cause more trouble than all the rest combined. The same packing used upon marine engines is absolutely steam tight, and it can be kept so on locomotives.

Probably higher steam pressures and increased severity of service which allows but little time for work at roundhouses accounts for some of the trouble. The pooling system has tended to remove the factor of personal interest in their engines on the part of the engineers, and in the old days of fibrous packing the men who ran the engines gave packing the frequent and faithful attention which it needed.

Nowadays, the metallic packing comes in neat packages ready to be thrown into place, and it is no one's special business to see that it hits the mark, that it fits the cup and the rod and that it receives the proper amount of the right kind of lubricant. Light engine oils are often used, and these do not stand the heat of the steam. Valve oil or some lubricant which will not evaporate or blow off is needed. In California crude fuel oil, which resembles tar, has been used successfully. In some places no oil whatever is used.

Some roads do not bore out the packings at all, others do not fit it to the rods, and as it is supposed to be, to a certain extent, self-adjusting, the fitting is sadly neglected. They even contend that packing rings as they leave the mold without being machined are as good as those machined. Why do not these same people contend that it is unnecessary to bore a cylinder or turn a piston? No wonder it leaks. Piston and valve rods should be ground accurately and not filed. They should be fitted up to definite sizes and the packing bored to suit. The cups should be fitted accurately to gauges and great care used to finish the sets of packing so that they will fit. This is a matter of grave importance, and the situation absolutely requires the attention of specialists who have made a study of packing and may be held responsible for the practice of an entire road. Such men should study their specialty at the works of the packing manufacturer and apply a systematic method at all roundhouses. There is no other way to fix this situation which is neither safe or creditable. "Rod packing cannot be satisfactorily handled with a shovel." Worse troubles than this have been overcome and "motive power officials will not long be excused for the neglect of this problem." These are the words of a well-known railroad officer. If metallic packing is given a fair chance it will do all that is required of it. The fact that there is a turning back a quarter of a century toward fibrous packings and that this is spoken of seriously as a remedy of present difficulties is a severe comment upon the situation.

ENCOURAGE THE WATER-TUBE LOCOMOTIVE BOILER INVENTION.

Locomotives may yet be fitted with water-tube boilers. This type of boiler offers special advantages for locomotive service and these are sufficiently important to justify every encouragement to those who are seeking to find a satisfactory way to design one.

In marine service it is held that, aside from the destructiveness of corrosion, the life of a Scotch boiler varies in inverse ratio to the number of times steam is raised. A water-tube boiler is not subjected to such severe distress from this cause and its parts are free to adjust themselves to rapid changes in temperature. In the locomotive boiler we have an aggravated case of distress because of frequent and even violent changes of temperature, to which a large proportion of boiler difficulties, especially the leakage of tubes, is undoubtedly due.

As to the matter of rapid steam raising with water-tube boilers, the following, from a paper by Mr. Wm. A. Fairburn, read before the Society of Naval Architects and Marine Engineers, is noteworthy:

"The Babcock & Wilcox boiler, of a small tube type, in H. M. S. Sheldrake, when tested by the British Admiralty, gave the following results: Steam raised to working pressure from water at 70 degs. in 23 minutes. Period of time from fires being drawn and water blown out to drawing tubes, 24 minutes.

"Representatives from the United States Navy Department, when making a test of the Babcock & Wilcox boiler built for U. S. S. Alert, found that the working pressure of the boiler, 225 lbs., was reached 26¾ minutes after the fires were lighted. With a similar boiler built for the U. S. S. Cincinnati, 215 lbs. steam pressure was obtained in 12 minutes and 40 seconds after the fires were started."

Such rapidity of "firing up" would be appreciated to-day in the roundhouse. As to boiler pressures, the author of this paper says that there is practically no limit to the pressure that may be carried in a water-tube boiler. If the pressure becomes very excessive, the size of steam drum may ultimately have to be decreased and unusually powerful bending rolls built for shaping these small heavy drum plates. At the present time the tendency is to increase the volume of the steam and water spaces in these boilers by using larger drums than was the custom a few years ago. The present proportions could, without difficulty, be adopted for any working pressure up to 500 lbs. Therefore, at the present time the limit to the practicable high working pressure is determined by the engines. A Scotch boiler of moderate size for large steamship work, say 16 ft. diameter, built for a working pressure of 250 lbs., will require a shell 1⅞ ins. thick, and the rivets will be so large that only hydraulic machinery of very massive type can drive them. If a boiler of this size was intended for 300 lbs. working pressure, the shell would be about 2¼ ins. thick. This suggests the possibility of a great saving in weight in the water-tube type if it can be applied to the locomotive.

Put to the fresh college graduate the problem of the amount of distance to be left between the conductors of a high-tension transmission line. His answer will involve most likely the jumping distance of the voltage to be used, the length of span, the sag, and perhaps a liberal factor of safety. It is experience only that will show that his premises are wrong and that the equation to determine spacing of high-tension wires depends very little on the voltages to be carried and almost entirely on such things as the average length and ohmic resistance of cats, the spread of wing of owls and cranes and eagles, and the average length of scrap baling wire, together with the strength of the average small boy's throwing arm.—**P. M. Lincoln, before the Canadian Electrical Association.**

A NOVEL APPLICATION OF ELECTRIC DRIVING TO A QUARTERING MACHINE.

Mexican Central Railway.

The engraving presented below illustrates an interesting new design of mounting electric motors for driving a quartering machine. Special features are incorporated which make the drive a model for simplicity, while it is also a radical departure from previous methods of driving tools of this kind.

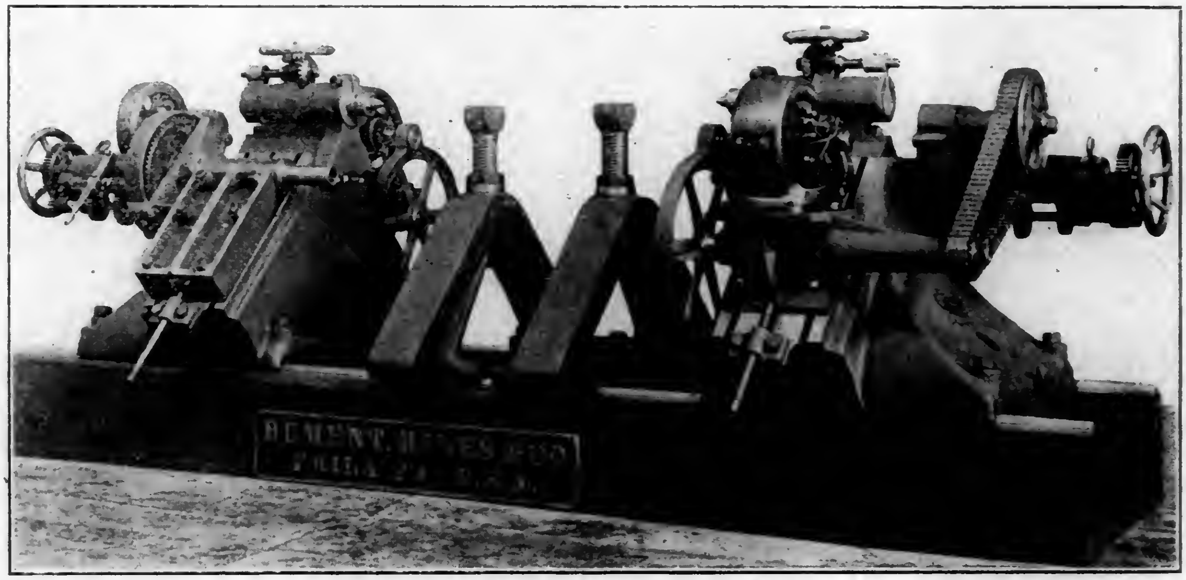
This tool is an 85-in. quartering machine (interchangeable for quartering for right or left hand lead), recently built by the Bement, Miles & Co. works of the Niles-Bement-Pond Company, New York, for the Mexican Central Railway. It is to be installed at the new shops of this road, which will soon be completed at Aguas Calientes, an important division point 860 miles south of the El Paso, Tex., terminal and 585 miles north of Mexico City. In these new shops, which are notable for the use in their power plant of De Laval steam turbines driving Milwaukee direct-current generators, generous provision has been made for the use of electric driving. A three-wire system of distribution is delivering 250 volts for lighting circuits and 500 volts for power for operating the drives. Some interesting motor driving equipments are to be installed, of which this outfit is representative.

The machine is driven individually at each head by 3½-h.p. constant-speed motors built by the Crocker-Wheeler Company, Ampere, N. J. The mountings for the drives are unusually interesting. Each motor rests upon a triangular-shaped block, arranged to slide on the inclined ways of the heads. This block also, by means of an extended sleeve, serves as a bearing support for the back shaft, which is driven directly from the motor pinion. Power is delivered from this intermediate shaft to the spindle drive at a considerable speed reduction through a Renold silent chain in either case. These chains are very easily tightened by merely lowering the motor blocks by means of the adjusting screws shown.

The tool is designed for quartering and boring crankpin holes in driving wheels up to 80 ins. in diameter on the tread. The usual centers are provided for centering the axles, as well as also the vertically adjustable V-blocks for supporting them, and to which the wheels are clamped. The boring spindles have 15 ins. traverse, and are provided with two changes of power feed, which are controlled by the clutch handle at the rear of the chain drive.

The most important feature of this design of driving is the provision for changing around for quartering with left instead of right hand lead. In either case the motor is located on the inclined ways on the opposite side of the head from the boring spindle which it drives. In changing the tool over, the positions of the motor and supporting block, and the boring spindle with its fixtures are merely reversed; this is accomplished by turning both the motor block and the spindle-bearing block upside down and bolting to the ways on the other side, each being so constructed as to fit on the inclined ways with either side up. In this way the relative locations and principal dimensions of the drive are not altered.

The effect of this design of drive is to make a much more compact arrangement than is usual where the motor is located elsewhere on the head. An idea of the neatness and simplicity effected by this arrangement may be gained from reference to the 84-in. motor-driven quartering machine in use at the Collinwood shops of the Lake Shore & Michigan Southern, which was illustrated on page 45 of our February issue. In this case the motor is mounted upon a bracket at the rear of the head, and the complication necessary to render the tool reversible is apparent.



A NEW DESIGN OF ELECTRIC DRIVING FOR A QUARTERING MACHINE. DRIVEN BY A 3½-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR UPON EACH HEAD.

YOUNG MAN'S CHANCES TO-DAY.

A young man of capacity, industry and integrity has a field for individual effort such as has never before existed in this country, says Edward Bok. And success is neither harder nor easier than it ever was. Success never yet came to the laggard, and it never will. His success depends upon himself. No times, no conditions, no combinations of capital can stop a young man who has a determination to honorably succeed, and who is willing to work according to the very utmost of his capacity and sinews of strength. The real trouble is that the average young man won't work. He has gotten the insane notion into his head that success comes by luck; that men are made by opportunities which either come to them or are thrust upon them. And he waits for luck or a chance to come along and find him. Instead of taking a sane view of conditions and seeing with a clear mind that as trade widens opportunities increase, he takes the mistaken view that the rich are getting richer and the poor poorer. These are the conditions of mind and life which are keeping thousands of young men down, and will keep them down. The times are all right. It is the young man who finds fault with them who is not.—*Graphite.*

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

Nothing has appeared in connection with improvement in passenger car construction which can compare in importance with the new suburban equipment of the Illinois Central Railroad. Leaving entirely out of consideration the special side-door features and the means for rapid loading and unloading, the cars mark an introduction of new ideas which must, because of their merit, become important factors in the future. Here is a car which no collision is likely to demolish; one with a steel frame which requires no wood for purposes of adding strength, and one with a steel floor which is merely covered with a carpet of wood. It needs but little radical changing to make it an all steel car which will be light, strong and fireproof. It now weighs 61,400 lbs. in the body and 23,200 in the trucks and may be made much lighter without sacrifice of strength. It is not said that this is a perfect car. It is, however, a step in the direction which car construction for this service must take and is a hopeful indication of the possibility of building lighter cars which will be both stronger and safer than can be obtained with prevailing methods of construction.

Rapid progress is being made in the use of gas for furnace heating and power production in internal combustion engines. Mr. Sanderson directed attention to the possibilities of the internal combustion engine in his paper before the Master Mechanics' Association last June. As a matter of fact greater progress is being made than was indicated at that time. At the navy yard at Portsmouth, Va., gas fuel is used exclusively in blacksmith's work. Another good example of similar use is to be seen at the National Tube Works at Harrisburg, Pa., and still another at the works of the Winchester Repeating Arms Company, New Haven, Conn., where every forging, from a breech of a 5in. gun down to a cartridge ejector for a pistol is made by use of gas.

A New York concern has perfected gas plants, making gas from cheap fuel, which may be used in gas engines without gumming them up, and requiring very little purification. This process also supplies a gas with high heating value, which gives excellent results in welding operations. Also in England a well-known manufacturer of gas engines is now bringing out gas producers of small size and at small cost, with a view of operating them like boilers for small isolated plants

In these days most tools are bought for certain definite purposes. As an instance, take the case of small connecting rods, for which it will be decided that they are best dealt with in a taper turning lathe. Now, it is easy to calculate the exact length of time it should take to turn a given amount of surface. One can settle upon, say, 20 ft. per minute cutting speed with a feed of one-eighth roughing and three-sixteenths finishing. The total time required for the actual machining will be the maximum efficiency you have settled upon. When ordering a lathe for doing this work why should you not have a guaranteed time stated by the maker? Manufacturers of certain special tools do advertise to sell their machines on some such conditions, but the practice is very exceptional, and most tool makers absolutely ignore it. Attention paid to this question of time efficiency would do a great deal to improve the design and construction of many tools.

Readers say, "Your paper is full of good things in new shops, but tell us something about how to get good work out of the old tools most of us must use." Here is something for them: The writer found a Bement & Miles cylinder borer which has been run by the same man for the past 18 years, and he is still running it. It bores cylinders from 24 to 42 ins. in diameter. A new foreman was appointed, and the machine hand was encouraged to show what the old machine could do when driven by a new motor, but the speed of the boring bar has not been changed. By shrinking ½-in. rings on two of the feed cones, by using the former finishing-cut cone for roughing cuts, discarding the former slow-feed cones altogether, and by using three cutters in place of one, he now sets a cylinder, faces off

the ends, bores a roughing cut, a finishing cut, counterbores and faces off the flanges in three hours. For 17½ years the usual time for exactly the same work was 14 hours. The man now wants a 10-h.p. motor instead of a 5-h.p., and six cutters instead of three. He told the writer that he would gladly "cut the time in two" if he had the larger motor and a controller placed within reach, instead of against a column where he must take three steps to reach it. Now if "something happens" the cutters, and perhaps also the cylinder, are gone while he takes these steps. This old machine is rigid and fully equal to its present work. It makes a 5-h.p. motor heat up to a high degree, running as it is. The roughing cut of ⅜ in. and 5-16-in. feed goes through in 35 minutes. The cutting speed is 25 ft. per minute with the three cutters in a 20-in. cylinder. The writer timed the spindle roughly at four turns per minute.

SHOPS IN DESERT WASTES.

In the matter of selection of location for new railroad shops, difficulties have arisen which are as intricate as they are important, and point is given to these remarks by two cases in which it has been found impossible to effect a satisfactory shop organization in a reasonable time. The reason is that the shops have been built without sufficiently considering the labor market and fine new plants have been erected upon desert wastes as far as suitable facilities for housing the men are concerned. If it is desirable to locate shops at points remote from large cities something must be done to provide homes for the men or the best and steadiest men will not be had. This is not a matter of sentiment—it is to be expected as a matter of course. Railroads are sure to be disappointed if they expect good men to fill their shops and remain, steady and loyal, when the wages are less than those of manufacturing establishments and when they must necessarily live a long distance from their work. The question of wages is not now under discussion, but much might be said about that. The "shop train" does not solve the difficulty. There is no one thing to be done to attract and keep the best and steadiest men, but there are many factors in this problem, and they have not yet received the attention they deserve. Those who believe that shops can be located with reference to the convenience of the road itself without regard to the human problem involved, are likely, in time, to discover their mistakes. Much might be learned in this connection from the largest and most successful industrial establishments. These locate in or very near large cities or they in some way make it possible for employees to live comfortably within a reasonable distance of the works. They do not expect water to "flow up hill."

BIG LOCOMOTIVES AND THE COMPOUND.

BIG LOCOMOTIVES.

It seems to be sufficiently demonstrated that for business reasons we must have large and powerful locomotives. Whether they are popular or not, we must have them. It appears altogether improbable that there will be even a halt in the development of more powerful units, and there can be no backward movement, so firmly is the big engine entrenched. This is not a matter of individual opinion, but is because of a business development in transportation which has brought the heavy train and the enormous ocean liner. It is a part of the application of commercial principles to railroad transportation which began about ten years ago. Having the big engine, the problem is—how to make it satisfactory.

The failures of big engines are loudly proclaimed. They have failed in some ways. They have exposed many weaknesses, some internal in matters of design and others external, for which they are in no way responsible. Tractive power ranging from 40,000 to 57,000 lbs. involves great forces, necessitating good design and most careful construction. In such large units difficulties develop which have never been serious in small ones, and therefore entirely new problems have arisen. Those who have already done so much for the locomotive will not now hesitate or fail.

It seems necessary to turn toward that construction which disposes of the present enormous stresses by dividing them up among a larger number of parts which may be made smaller and lighter and arranged so as to best sustain the stresses.

One of the external weaknesses now brought to light is the inadequacy of even the best roundhouses, their equipment and efficiency for running repairs. The pooling system on many roads came simultaneously with heavier locomotives and also other changes whereby the locomotive was deprived of the interested individual attention of the men who ran it. This and the "prod" system of operation now give the roundhouse a new importance and a new responsibility. The largest engines on some roads cannot enter the roundhouses at all because of their size. They are sometimes too long for the turntables and require Y tracks for turning. They can be operated only on certain districts having specially heavy rails. In other places rails have been turned over and broken and bridges endangered. Side tracks have failed to contain the cars and draft gear to bear the strain due to the loads big engines can pull. Big engines have also exposed weaknesses in the offices of train dispatcher and superintendent. An old 6-in. spout does not fill a 7,000-gallon tender tank as quickly as one of 4,000 gallons. Shops without heavy cranes cannot lift big engines off their wheels and there are many of these archaic establishments about the country. In short, the big engine is about to show the need of several revolutions in railroad operation, and no wonder it is not popular. Nevertheless, large units of locomotive power constitute the force which is to draw the other factors of operation into line and this will mean more in terms of net earnings than any other influence now available.

Railroad owners who are wise will meet this problem immediately and generously. Motive power officers who are to do their part will have plans ready for a development toward heavier "power" in steps which will not swamp the other departments and will be prepared to recommend definite advances as often as warranted by their special conditions of service. Managers who are wise will see to it that their motive power departments are given the consideration required or they will soon find themselves in difficulties because of lack of motive power men of the right sort to deal with their part of the problem. This question needs immediate attention.

Those who are unwilling to properly maintain the big engines should expect them to fail, and they will surely continue to do so. Roads having many large engines cannot go backward. They are fortunate in that they must make them successful and thus become leaders in economical operation.

THE COMPOUND LOCOMOTIVE.

And what about the compound in this connection? Compounds are usually large engines. They are subject to all the difficulties faced by the big engine and more also. For example, roundhouses, roundhouse forces, shops and other facilities which are inadequate to keep up simple engines are less adequate to deal with compounds, for compounds need the "stitch in time" a little oftener than simple engines.

If railroads discard the compound it will be only a short time before they must return to it, and they will also find it necessary to adopt every other factor which will give increased capacity. Leaving out of account the fuel saving from the standpoint of economy, the limit to the physical endurance of the fireman will necessitate compounding. If automatic stokers succeed as oil burning has succeeded, compounding will be necessary in order to reduce the forcing of boilers and increase the life of fireboxes. The compound must be used because it will haul more tons than a simple engine and do the work easier with less forcing.

The compound does not need a champion. It is not the compound that is "in the balance," but the facilities for taking care of it and for securing the advantages which it is admitted cannot now be had by any other device.

A careful and extensive study of the operation of heavy locomotives under present conditions leads to the unqualified conclusion that the large locomotive must be successful and that it must be a compound.

HEAVIEST LOCOMOTIVE EVER BUILT.

2—10—2 TYPE, TANDEM COMPOUND.

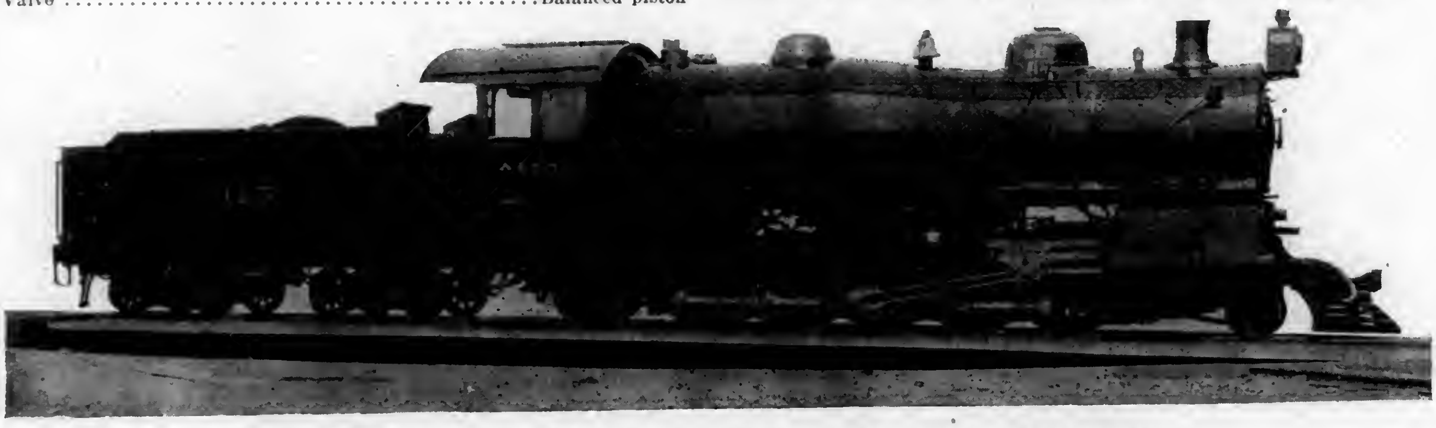
ATCHISON, TOPEKA & SANTA FE RAILWAY.

The Baldwin Locomotive Works are delivering 70 new locomotives of what is called the Santa Fe type to the Atchison, Topeka & Santa Fe Railway. These are the heaviest locomotives ever built, their total weight being 20,000 lbs. more than that of the 2—10—0 type for this road illustrated on page 192 of our June number of 1902. These new locomotives merit a complete detailed description, which will be presented in the next issue of this journal. The following table includes the chief characteristics of this remarkable design:

SANTA FE TYPE FREIGHT LOCOMOTIVE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Gauge	4 ft. 8½ ins.
Cylinder	19 ins. and 32 ins. x 32 ins.
Valve	Balanced piston



THE HEAVIEST LOCOMOTIVE EVER BUILT—ATCHISON, TOPEKA & SANTA FE RAILWAY.
SANTA FE TYPE (2-10-2) TANDEM COMPOUND. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

Boiler	Type, wagon top; material, steel
Diameter	78¾ ins.
Thickness of sheets	⅞ in. and 15-16 in.
Working pressure	225 lbs.
Fuel	Soft coal
Staying	Radial
Firebox—Material	Steel
Length	108 ins.
Width	78 ins.
Depth	Front, 80¼ ins.; back, 78¼ ins.
Thickness of sheets:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, 9-16 in.
Water space	Front, 4½ ins.; sides, 5 ins.; back, 4 ins.
Tubes—Material	Iron. Wire gauge, No. 11
Number	391
Diameter	2¼ ins.
Length	20 ft.
Heating surface—Firebox	210 sq. ft.
Tubes	4,586 sq. ft.
Total	4,796 sq. ft.
Grate area	58.5 sq. ft.
Driving wheels—Diameter outside	57 ins.
Diameter of center	50 ins.
Journals	Main, 11 x 12 ins.; others, 10 x 12 ins.
Engine truck wheels (front)—Diameter	29¼ ins.
Journals	6½ x 10½ ins.
Engine truck wheels (back)—Diameter	40 ins.
Journals	7½ x 12 ins.
Wheel base—Driving	19 ft. 9 ins.
Rigid	19 ft. 9 ins.
Total engine	35 ft. 11 ins.
Total engine and tender	66 ft.
Weight—On driving wheels	234,580 lbs.
On truck, front	23,420 lbs.
On truck, back	29,240 lbs.
Total engine	287,240 lbs.
Total engine and tender (about)	450,000 lbs.
Tank—Capacity	8,500 gals.
Tender—Wheels	Number, 8; diameter, 34¼ ins.
Journals	6½ x 10 ins.

MOTOR DRIVEN ICE MACHINES.

Refrigerating machines driven by electric motors appear to be very satisfactory. Mr. Fred L. Kimball makes the following statement in an article in *Engineering Magazine*: "The cost of refrigeration under this system is not prohibitive even when electricity is supplied from coal-burning stations. In a certain installation which was visited recently, it was found that a machine of 1-ton nominal capacity, operated by a 3-h.p. motor, was furnishing refrigeration for a storage room 25 ft. x 15½ ft. x 8 ft. and a delivery chest 20 ft. x 1 ft. 8 ins. x 6 ft., at an expense of $1 per day—the average temperature obtained being 42 degs. Of this $1, 56 cents was for electricity and 44 cents for water. The current was supplied by meter at 3 cents per kw.-hour, and the water at 12 cents per 1,000 gals." The whole plant cost $1,000, repairs for 18 months cost less than $5, and the saving over the cost of ice averaged $12 per week, ice costing $3 per ton. This may interest railroad officers who are paying high prices for ice.

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MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

X.

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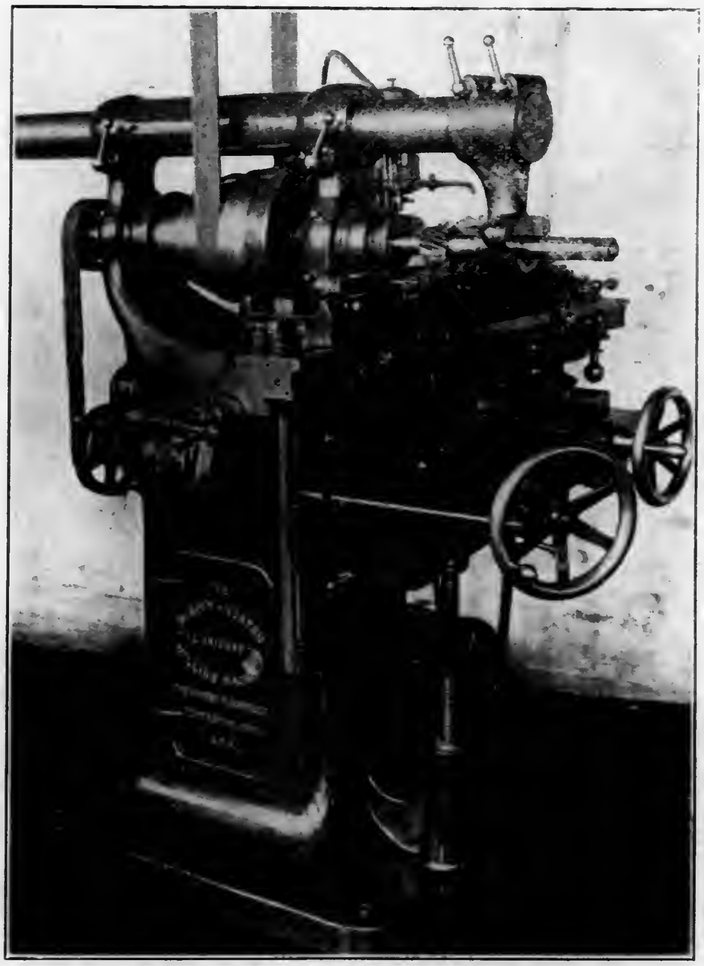

FIG. 49.—VIEW OF THE HENDEY-NORTON MILLING MACHINE, SHOWING CONVENIENT ARRANGEMENT OF THE SPEED-BOX IN THE FRAME AT THE LEFT.

The speed box is of renewed interest, in this application, particularly for the method of adaptation to milling machine conditions.

The device, as arranged for use in this case, is shown in detail in the drawing, Fig. 50, and its location upon the milling machine is indicated in the engraving, Fig. 49. The entire mechanism is located within the frame, and is thus quite out of the way and protected from dirt and chips. In this way the mechanism requires much less than would the belt cone and pulley arrangement.

The mechanism is driven by a belt connection to the spindle, the belt and pulleys appearing at the rear of the tool in Fig. 49. The lower pulley is keyed on the shaft which carries the shifting pinion, the latter being the driving member in this case as in the feed box used upon the Hendey-Norton lathes. The feeding motion is delivered to the table from the upper shaft which carries the cone of gears, the connection to the table being made through a telescoping shaft and universal joints, at the rear of the frame, in the usual manner.

The driving shaft for the mechanism is shown at D, Fig. 50, and the shifting pinion which it carries appears at O. This pinion, O, feathers with shaft D, and is controlled in its longitudinal movement by frame F, which embraces it by the forked projections pivoting on shaft D. The gear, P, is also carried in this frame in permanent mesh with pinion, O, gear P, being the one which is used for meshing with the gears of the cone. This is accomplished as in the device used upon their lathe, by lifting the handle, H, outside and locking it in one of the slots in the index plate X. Shaft S, carries the cone of gears and it is from this that the power is delivered to the table feeds.

In this way pinion O, which always revolves with driving shaft D, drives gear P, which, when brought up into mesh with any of the gears of the cone, drives the latter and with it, the delivery shaft S. Thus handle H is instrumental in not only starting and stopping the feeds, but also in making seven changes of feeding speed (six changes only on the No. 2 milling machine).

The small vertical slots in the index plate X, and the spring locking latch on handle H (as shown in Fig. 50), ensure proper meshing of the gears and also prevent interference of gear P, with the others of the cone on either side of the one driven.

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The design of the feeding mechanisms for the Hendey-Norton milling machines is particularly heavy and rigid, the desire having been to render them capable of the heaviest duty for rapid production in milling processes. The result has been that some remarkable instances of heavy milling performances have been accomplished in many cases. For example, the photograph, from which the engraving, Fig. 49, was made, was taken while a remarkably heavy milling performance was being made, the conditions of which are as follows: The machine used was the No. 2 universal Hendey-Norton miller, with no special adjustments, and the stock being milled was a bar of 50-point carbon steel with 1⅞-inch face. In one instance, a one-eighth-inch cut was taken with the feed mechanism set for

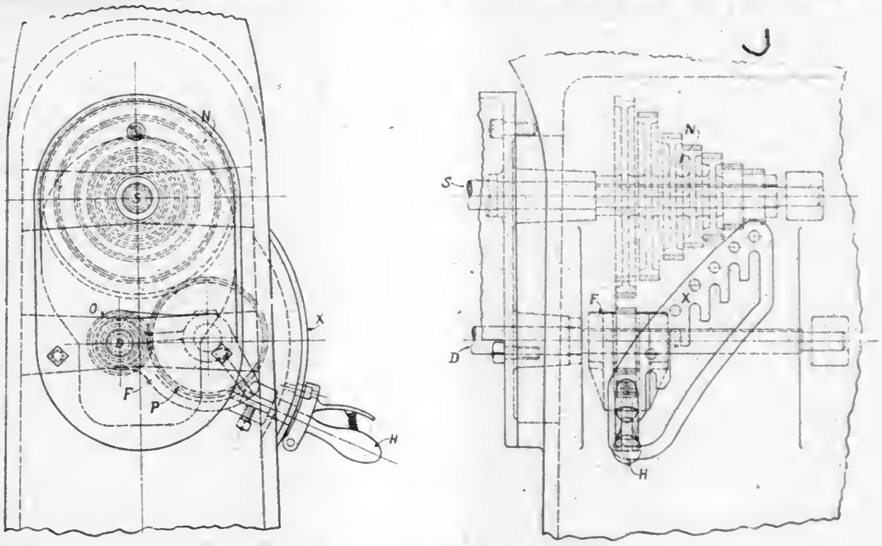


FIG. 50.—DETAILS OF THE VARIABLE-SPEED FEED MECHANISM APPLIED TO THE HENDEY-NORTON MILLING MACHINE.

HEAVIEST LOCOMOTIVE EVER BUILT.

2—10—2 Type, Tandem Compound.

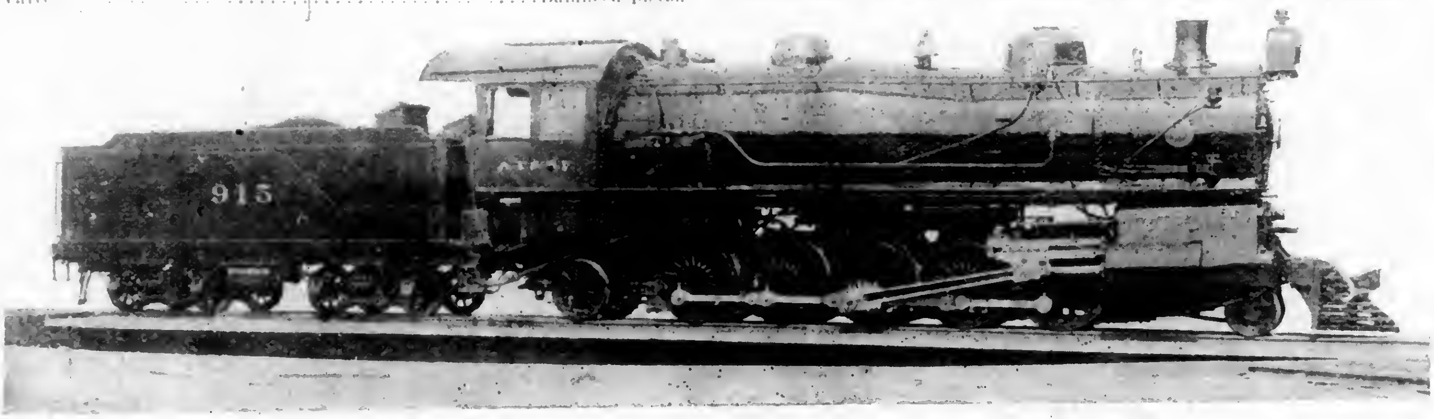
Atchison, Topeka & Santa Fe Railway.

The Baldwin Locomotive Works are delivering 70 new locomotives of what is called the Santa Fe type to the Atchison, Topeka & Santa Fe Railway. These are the heaviest locomotives ever built, their total weight being 20,000 lbs. more than that of the 2—10—0 type for this road illustrated on page 192 of our June number of 1902. These new locomotives merit a complete detailed description, which will be presented in the next issue of this journal. The following table includes the chief characteristics of this remarkable design:

SANTA FE TYPE FREIGHT LOCOMOTIVE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Gauge	4 ft. $8\frac{1}{2}$ ins.
Cylinder	19 ins. and 32 ins. x 32 ins.
Valve	Balanced piston



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SANTA FE TYPE (2-10-2) TANDEM COMPOUND. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

Boiler	Type, wagon top; material steel
Diameter	$78\frac{3}{4}$ ins.
Thickness of sheet	$\frac{7}{8}$ in. and 15-16 in.
Working pressure	225 lbs.
Fuel	Soft coal
Staying	Radial
Firebox—Material	Steel
Length	108 ins.
Width	78 ins.
Depth	Front, $80\frac{1}{4}$ ins.; back, $78\frac{1}{4}$ ins.
Thickness of sheet:	Sides, $\frac{3}{8}$ in.; back, $\frac{3}{8}$ in.; crown, $\frac{3}{8}$ in.; tube, 9-16 in.
Water space	Front, $1\frac{1}{2}$ ins.; sides, 5 ins.; back, 1 ins.
Tubes—Material	Iron. Wire gauge, No. 11
Number	391
Diameter	$2\frac{1}{4}$ ins.
Length	20 ft.
Heating surface—Firebox	210 sq ft.
Tubes	1,586 sq. ft.
Total	4,796 sq. ft.
Grate area	58.5 sq. ft.
Driving wheels—Diameter outside	57 ins.
Diameter of center	50 ins.
Journals	Main, 11 x 12 ins.; others, 10 x 12 ins.
Engine truck wheels (front)—Diameter	$29\frac{1}{4}$ ins.
Journals	$6\frac{1}{2}$ x $10\frac{1}{2}$ ins.
Engine truck wheels (back)—Diameter	40 ins.
Journals	$7\frac{1}{2}$ x 12 ins.
Wheel base—Driving	19 ft. 9 ins.
Rigid	19 ft. 9 ins.
Total engine	35 ft. 11 ins.
Total engine and tender	66 ft.
Weight—On driving wheels	234,580 lbs.
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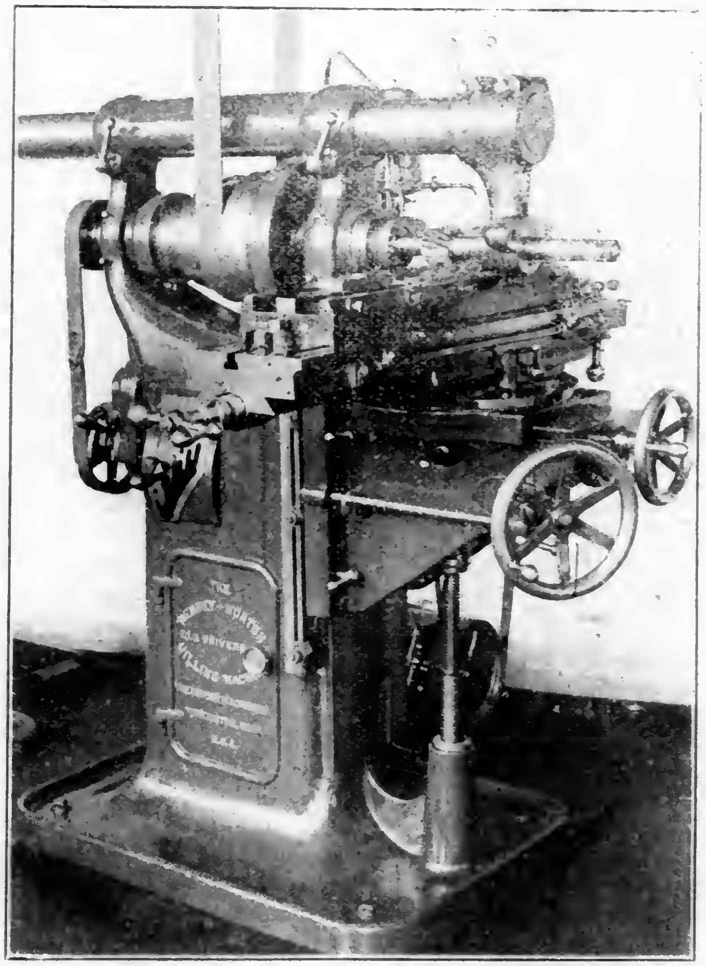

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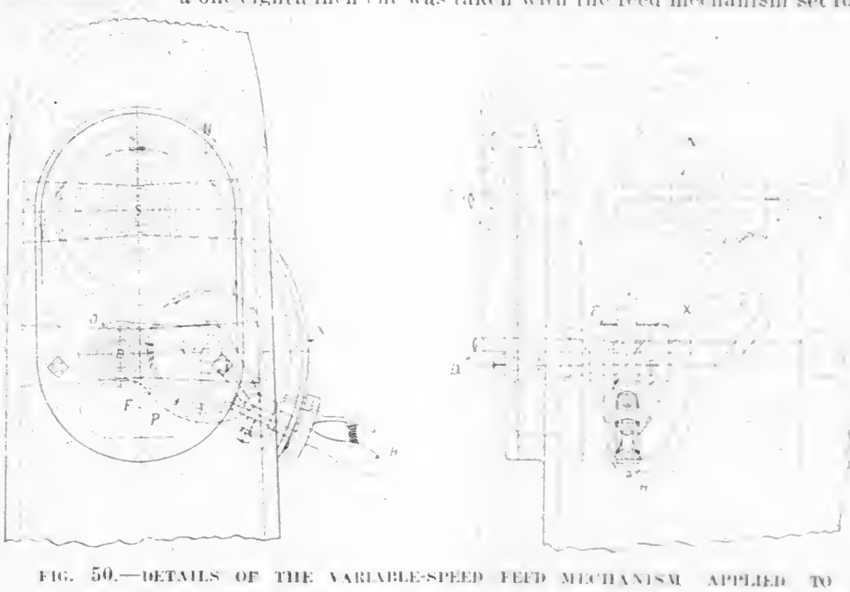

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a table feed of 3 1-3 inches per minute, and in another, a 1-10-inch cut was taken with a table feed of 4 inches per minute. In both cases the work was carried very easily and no trouble was met in any way. This heavy performance was made with no special preparations, a stock arbor and a stock cutter being used, and also the arbor support was not set as close to the cutter as would ordinarily have been done. This is another important proof of the advantage to be gained from the use of the heavy gear-drive feeding mechanism.

THE MACHINE SHOP PROBLEM.

The following paragraphs are selected from a paper read before the American Society of Mechanical Engineers by Mr. Charles Day:

Reviewing, briefly, past conditions in the majority of shops —and in fact many of to-day—we cannot fail to be impressed by the slipshod methods in use on all hands. Purchase of equipment was left almost invariably to a purchasing agent who was in no way conversant with the requirements of machines to be bought, price being his only means of comparison. The fact that such a condition of affairs was allowed to exist was sufficient proof that those in charge of the shop were scarcely more capable to judge of the earning power of the apparatus than he.

Some of the largest shops used a cheap grade of carbon steel for cutting tools, instead of the "air-hardening" variety which would permit of double the cutting speed, the reduced first cost being their reason for this policy. In such a plant five thousand dollars ($5,000) invested in tool steel might readily effect a saving on the labor bill of fifteen thousand dollars ($15,000) annually. Such an illustration exemplifies forcibly the absence of scientific thought and investigation existing but a few years since.

Probably nothing has increased the possibilities of the machine shop to a greater degree than the power crane, and although the designer of the building is always informed, in a general way, as to the crane service that will be required, this detail is not usually given nearly sufficient consideration. To properly cover the floor space with power cranes, jib cranes, etc., requires a most careful study of the location of various machines, which, in turn, necessitates a thorough understanding of the work in view.

The lighting of the machine shop or foundry to a marked extent influences the efficiency of the men, and the importance of this fact is generally appreciated at this time. It is practically impossible to obtain too much light, provided the direct rays of the sun do not fall on the work. As large establishments usually run night and day, a liberal amount of artificial light is also necessary if the different shifts are to turn out equal amounts of work. Shops that are illuminated in a general way by arc lamps (as well as incandescent lights for detail work) seldom complain of the inefficiency of the night shift.

The efficiency of machine shop equipment should be judged only from its ability to produce the desired result at a minimum cost, and this, in turn, is governed as much by the information at the disposal of the operators as the machines themselves. In the extreme case, such as a full automatic screw machine, we might suppose that the ability of the designer would assure the success of the tool; but even in this case innumerable details arise, such as the grinding and setting of cutters, the delivery of stock to and from the machine, etc., which may or may not be efficiently taken care of by the purchaser.

Turning to the other extreme—an engine lathe doing a general class of work—we find the workman confronted by innumerable problems, governing economical production, which he, and in many cases his superiors, fail to recognize. For example, the proper cutting speeds for different materials and different cuts; the relative advantage of a heavy cut and slow speed, or a light cut and fast speed; and the capabilities of the machine. These are but a few of the details. Such information can only be obtained from experimental work carried on along scientific lines, and as long as schemes of management take no cognizance of this data, the introduction of modern tool steels, the motor drive, etc., will necessarily be slow; consequently we cannot discuss the merits of various types of apparatus, unless conversant with the problems of organization and management. The absence of this knowledge leads many engineers to most erroneous conclusions.

The small attention given to the cutting tool in the vast majority of shops is astonishing when we realize how directly the time of machining is dependent on the character of the steel. We are all constantly hearing of phenomenal cutting speeds, etc., but it is the efficiency of the tools in the tool racks that is a gauge of their value. If these tools are not forged and ground to standard angles and reground by a man who realizes fully the care which must be exercised in this work, the chances are that the majority of them will be but scarcely better than the original steel.

If a cutting tool is to work at its maximum efficiency, the cutting speed should be maintained constant for a given depth of cut and a given feed, consequently some means should be provided for accelerating the spindle speed of a lathe when the tool is working from a larger to a smaller diameter, such as facing cylinder heads, etc. A lathe of this character may be truly termed a variable-speed machine. In the average shop, however, there is very little opportunity for work of this kind, the majority of lathe work consisting of longitudinal cuts. If the lathe operates on but one class of work, the proper spindle speeds and feeds can be obtained, which should not be changed as long as conditions remain unaltered. If, on the other hand, a great variety of work is handled by a lathe, the tool will constantly work on different diameters, variable speed being equally as important in this case as in the first considered, although a uniform increase, as the work proceeds, would not be required. Simple as this classification may seem, the electrical engineer repeatedly fails to see that a system of motor driving that would be applicable in one case utterly fails in another.

Practically all machine shops have some variable-speed tools, and, here again, it is the province of the engineer to determine the relative importance of the various factors. A manufacturer who advertises a variable-speed countershaft or motor for machine-tool driving which will give any speed, shows his ignorance of shop conditions where a refinement of this kind cannot be used to advantage. In fact, after visiting practically all the shops that have installed multiple-voltage equipment offering the possibilities of close speed regulation and ease of handling, we are convinced that the purchasers are not beginning to realize an adequate return on the investment. A better illustration could not be found of the interdependence of management and equipment.

TO YOUNG MEN.

"There is plenty of room at the top, but there is no elevator in the building.

"There are times when it's safest to be lonesome.

"Being popular takes up a heap of time.

"Putting off an easy thing makes it hard, and putting off a hard one makes it impossible.

"Have something to say; say it; stop talking.—Rules for a business conversation.

"The house is not interested in knowing how you like your boss, but in how your boss likes you.

"Remember that when you're in the right you can afford to keep your temper, and that when you're in the wrong you can't afford to lose it.

"Enthusiasm is the best shortening for any job; it makes heavy work light.

"Remember that to-day is your opportunity, to-morrow some other fellow's.

"In keeping track of others and their faults it is very, very important that you shouldn't lose sight of your own."

These bits are gleaned from "Letters from a Self-Made Merchant to His Son."

WOODWORKING MACHINERY.

IMPORTANT DEVELOPMENTS IN INDIVIDUAL DRIVING BY ELECTRIC MOTORS.

In the August issue of this journal was presented (pages 294 to 296) an article treating of modern methods of electrically driving wood-working tools. As may be inferred from the same, problems of greater magnitude and complexity are there met than are prevalent with iron-working-tool practice, and necessarily they demand special treatment. In this article is presented additional examples of motor-drive equipments for wood-working tools, in order to indicate to those meeting problems of this nature what may be termed prevalent practice.

The tools illustrated herewith are representative examples selected from a large installation which the Triumph Electric Company, Cincinnati, Ohio, recently fitted up for electric power transmission and motor driving. The motors are all Triumph motors of the inclosed type, which are particularly adaptable to this class of driving, in which dust and shavings are met in quantities. A notable feature of this interesting installation is the conspicuous absence of overhead belts. The result is a beautifully light and airy shop, which will be thoroughly appreciated by those who have to do with belt-drive shops.

The first engraving, Fig. 1, illustrates an interesting direct-coupled drive on a 9-in. four-head sticker. This is an instance where the comparatively high speed of the motor agrees favorably with the driven speed of the machine, permitting a direct coupling between the armature shaft and the machine's drive. The motor used for this drive is the standard 15-h.p. floor-type Triumph motor, operating at 900 rev. per min. This drive is unexcelled for economy of space and neatness.

In this engraving is also illustrated one of the ceiling motor drives, which are used in this installation for driving the groups of light machinery. The group-drive method of arranging the machinery was adopted for the lighter tools, a grindstone and a wood lathe only being driven from the one motor in this case.

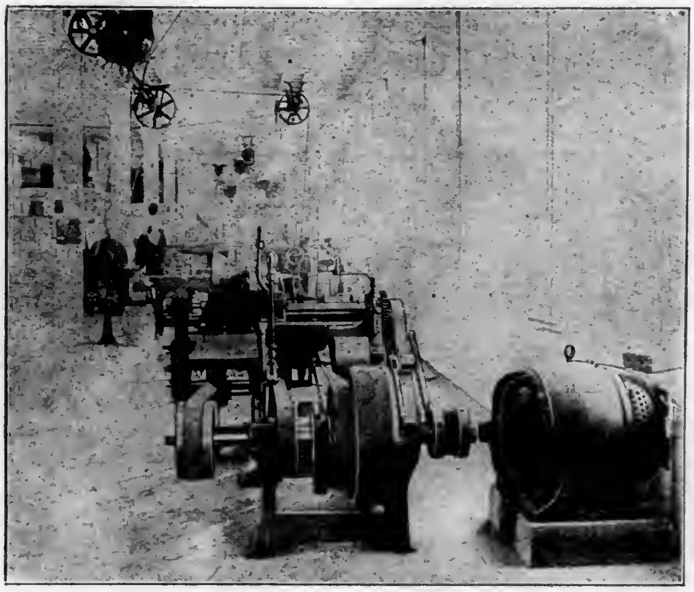

FIG. 1.—DIRECT-COUPLED DRIVE FOR A 9-INCH STICKER. DRIVEN BY A 15-H. P. MOTOR.

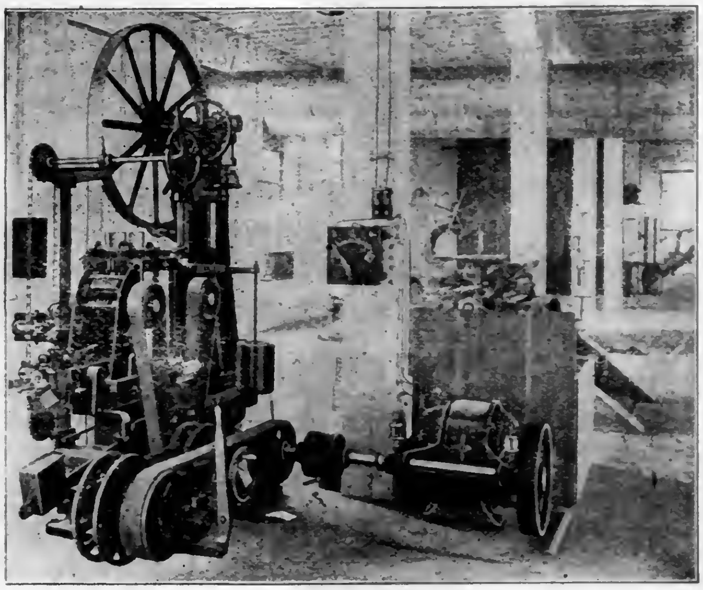

FIG. 2.—BAND RESAW, EQUIPPED WITH A DIRECT-COUPLED DRIVE FROM A 15-H. P. BACK-GEARED MOTOR.

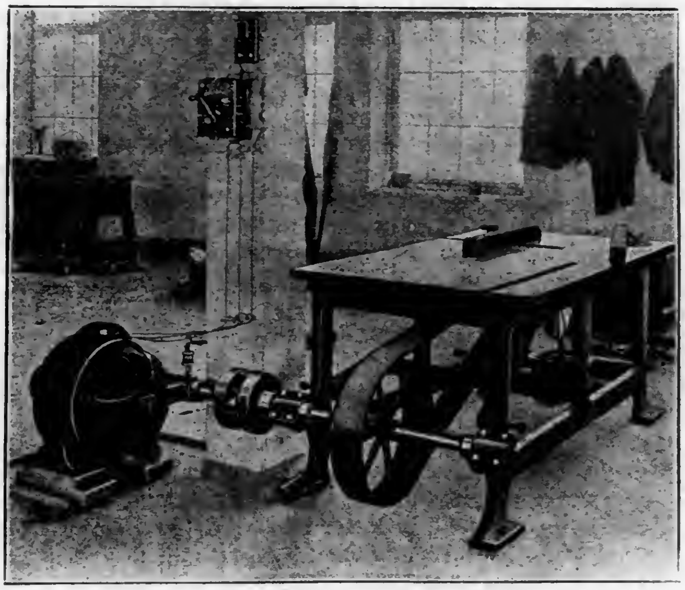

FIG. 3.—A 12-INCH RIP SAW WITH A DIRECT-COUPLED DRIVE FROM A 10-H. P. BACK-GEARED MOTOR.

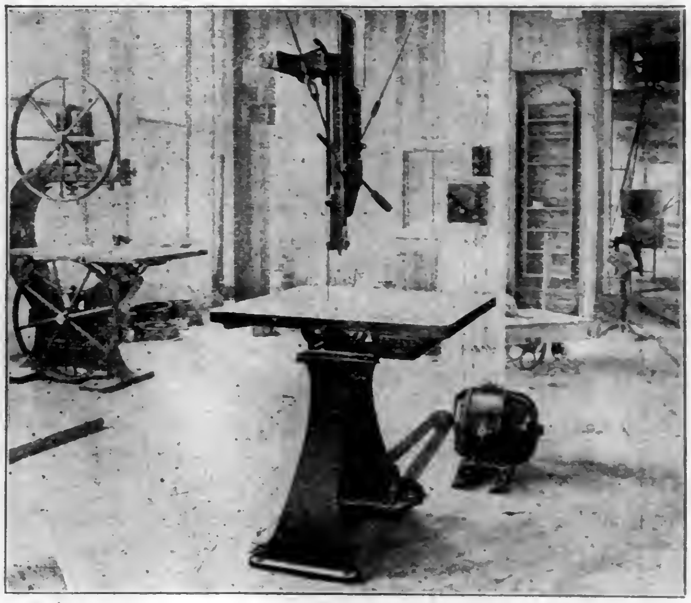

FIG. 4.—BELTED DRIVE FOR A JIG SAW FROM A 1-H. P. SLOW-SPEED MOTOR.

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a table feed of 3 1-3 inches per minute, and in another, a 1-10-inch cut was taken with a table feed of 4 inches per minute. In both cases the work was carried very easily and no trouble was met in any way. This heavy performance was made with no special preparations, a stock arbor and a stock cutter being used, and also the arbor support was not set as close to the cutter as would ordinarily have been done. This is another important proof of the advantage to be gained from the use of the heavy gear-drive feeding mechanism.

THE MACHINE SHOP PROBLEM.

The following paragraphs are selected from a paper read before the American Society of Mechanical Engineers by Mr. Charles Day:

Reviewing, briefly, past conditions in the majority of shops —and in fact many of to-day—we cannot fail to be impressed by the slipshod methods in use on all hands. Purchase of equipment was left almost invariably to a purchasing agent who was in no way conversant with the requirements of machines to be bought, price being his only means of comparison. The fact that such a condition of affairs was allowed to exist was sufficient proof that those in charge of the shop were scarcely more capable to judge of the earning power of the apparatus than he.

Some of the largest shops used a cheap grade of carbon steel for cutting tools, instead of the "air-hardening" variety which would permit of double the cutting speed, the reduced first cost being their reason for this policy. In such a plant five thousand dollars ($5,000) invested in tool steel might readily effect a saving on the labor bill of fifteen thousand dollars ($15,000) annually. Such an illustration exemplifies forcibly the absence of scientific thought and investigation existing but a few years since.

Probably nothing has increased the possibilities of the machine shop to a greater degree than the power crane, and although the designer of the building is always informed, in a general way, as to the crane service that will be required, this detail is not usually given nearly sufficient consideration. To properly cover the floor space with power cranes, jib cranes, etc., requires a most careful study of the location of various machines, which, in turn, necessitates a thorough understanding of the work in view.

The lighting of the machine shop or foundry to a marked extent influences the efficiency of the men, and the importance of this fact is generally appreciated at this time. It is practically impossible to obtain too much light, provided the direct rays of the sun do not fall on the work. As large establishments usually run night and day, a liberal amount of artificial light is also necessary if the different shifts are to turn out equal amounts of work. Shops that are illuminated in a general way by arc lamps (as well as incandescent lights for detail work) seldom complain of the inefficiency of the night shift.

The efficiency of machine shop equipment should be judged only from its ability to produce the desired result at a minimum cost, and this, in turn, is governed as much by the information at the disposal of the operators as the machines themselves. In the extreme case, such as a full automatic screw machine, we might suppose that the ability of the designer would assure the success of the tool; but even in this case innumerable details arise, such as the grinding and setting of cutters, the delivery of stock to and from the machine, etc., which may or may not be efficiently taken care of by the purchaser.

Turning to the other extreme—an engine lathe doing a general class of work—we find the workman confronted by innumerable problems, governing economical production, which he, and in many cases his superiors, fail to recognize. For example, the proper cutting speeds for different materials and different cuts; the relative advantage of a heavy cut and slow speed, or a light cut and fast speed; and the capabilities of the machine. These are but a few of the details. Such information can only be obtained from experimental work carried on along scientific lines, and as long as schemes of management take no cognizance of this data, the introduction of modern tool steels, the motor drive, etc., will necessarily be slow; consequently we cannot discuss the merits of various types of apparatus, unless conversant with the problems of organization and management. The absence of this knowledge leads many engineers to most erroneous conclusions.

The small attention given to the cutting tool in the vast majority of shops is astonishing when we realize how directly the time of machining is dependent on the character of the steel. We are all constantly hearing of phenomenal cutting speeds, etc., but it is the efficiency of the tools in the tool racks that is a gauge of their value. If these tools are not forged and ground to standard angles and reground by a man who realizes fully the care which must be exercised in this work, the chances are that the majority of them will be but scarcely better than the original steel.

If a cutting tool is to work at its maximum efficiency, the cutting speed should be maintained constant for a given depth of cut and a given feed, consequently some means should be provided for accelerating the spindle speed of a lathe when the tool is working from a larger to a smaller diameter, such as facing cylinder heads, etc. A lathe of this character may be truly termed a variable-speed machine. In the average shop, however, there is very little opportunity for work of this kind, the majority of lathe work consisting of longitudinal cuts. If the lathe operates on but one class of work, the proper spindle speeds and feeds can be obtained, which should not be changed as long as conditions remain unaltered. If, on the other hand, a great variety of work is handled by a lathe, the tool will constantly work on different diameters, variable speed being equally as important in this case as in the first considered, although a uniform increase, as the work proceeds, would not be required. Simple as this classification may seem, the electrical engineer repeatedly fails to see that a system of motor driving that would be applicable in one case utterly fails in another.

Practically all machine shops have some variable-speed tools, and, here again, it is the province of the engineer to determine the relative importance of the various factors. A manufacturer who advertises a variable-speed countershaft or motor for machine-tool driving which will give any speed, shows his ignorance of shop conditions where a refinement of this kind cannot be used to advantage. In fact, after visiting practically all the shops that have installed multiple-voltage equipment offering the possibilities of close speed regulation and ease of handling, we are convinced that the purchasers are not beginning to realize an adequate return on the investment. A better illustration could not be found of the interdependence of management and equipment.

TO YOUNG MEN.

"There is plenty of room at the top, but there is no elevator in the building.

"There are times when it's safest to be lonesome.

"Being popular takes up a heap of time.

"Putting off an easy thing makes it hard, and putting off a hard one makes it impossible.

"Have something to say; say it; stop talking.—Rules for a business conversation.

"The house is not interested in knowing how you like your boss, but in how your boss likes you.

"Remember that when you're in the right you can afford to keep your temper, and that when you're in the wrong you can't afford to lose it.

"Enthusiasm is the best shortening for any job; it makes heavy work light.

"Remember that to-day is your opportunity, to-morrow some other fellow's.

"In keeping track of others and their faults it is very, very important that you shouldn't lose sight of your own."

These bits are gleaned from "Letters from a Self-Made Merchant to His Son."

WOODWORKING MACHINERY.

IMPORTANT DEVELOPMENTS IN INDIVIDUAL DRIVING BY ELECTRIC MOTORS.

In the August issue of this journal was presented (pages 294 to 296) an article treating of modern methods of electrically driving wood-working tools. As may be inferred from the same, problems of greater magnitude and complexity are there met than are prevalent with iron-working-tool practice, and necessarily they demand special treatment. In this article

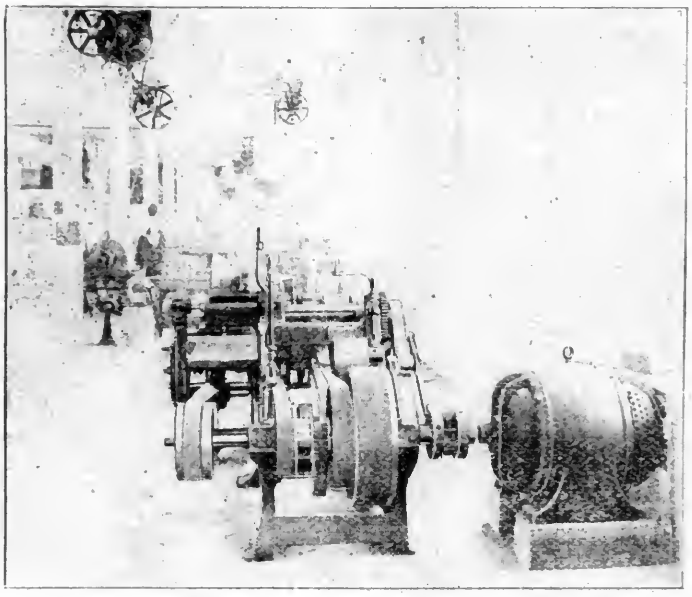
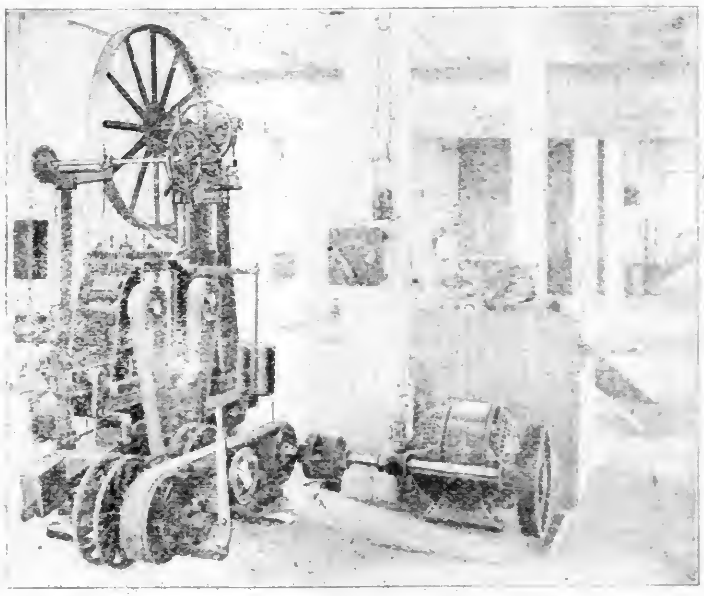


FIG. 1.—DIRECT-COUPLED DRIVE FOR A 9-INCH STICKER. DRIVEN BY A 15-H. P. MOTOR.



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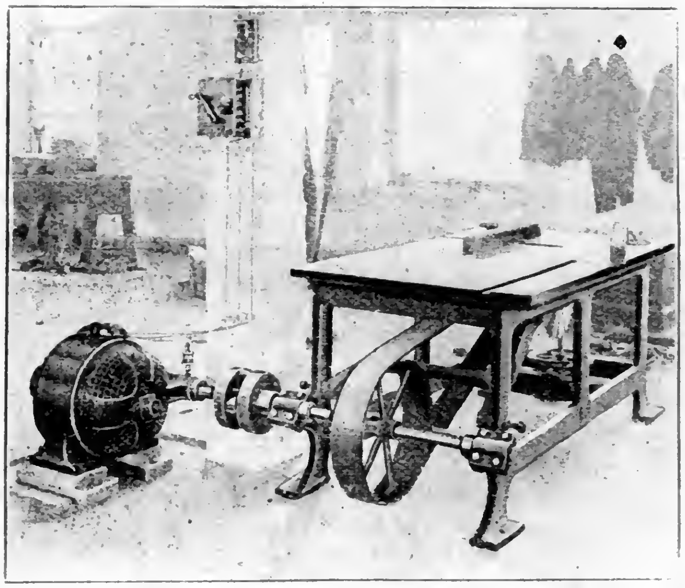

FIG. 3.—A 12-INCH RIP SAW WITH A DIRECT-COUPLED DRIVE FROM A 10-H. P. BACK-GEARED MOTOR.

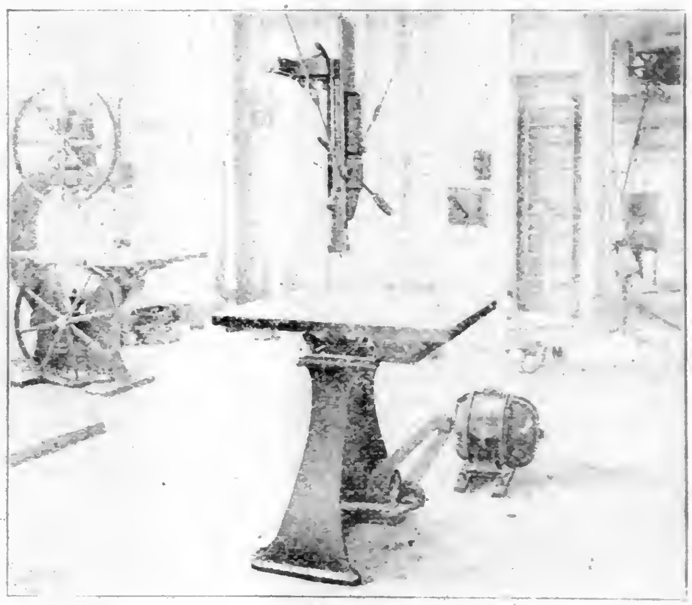

FIG. 4.—BELTED DRIVE FOR A JIG SAW FROM A 1-H. P. SLOW-SPEED MOTOR.

is presented additional examples of motor-drive equipments for wood-working tools, in order to indicate to those meeting problems of this nature what may be termed prevalent practice.

The tools illustrated herewith are representative examples selected from a large installation which the Triumph Electric Company, Cincinnati, Ohio, recently fitted up for electric power transmission and motor driving. The motors are all Triumph motors of the inclosed type, which are particularly adaptable to this class of driving, in which dust and shavings are met in quantities. A notable feature of this interesting installation is the conspicuous absence of overhead belts. The result is a beautifully light and airy shop, which will be thoroughly appreciated by those who have to do with belt-drive shops.

The first engraving, Fig. 1, illustrates an interesting direct-coupled drive on a 9-in. four-head sticker. This is an instance where the comparatively high speed of the motor agrees favorably with the driven speed of the machine, permitting a direct coupling between the armature shaft and the machine's drive. The motor used for this drive is the standard 15-h.p. floor type Triumph motor, operating at 900 rev. per min. This drive is unexcelled for economy of space and neatness.

In this engraving is also illustrated one of the ceiling motor drives, which are used in this installation for driving the groups of light machinery. The group-drive method of arranging the machinery was adopted for the lighter tools, a grindstone and a wood lathe only being driven from the one motor in this case.

The next two engravings, Figs. 2 and 3, as well as the ceiling motor illustrated in Fig. 1, present examples of the use of the Triumph Electric Company's back geared motor. Fig. 2 is a view of an inclosed floor-type, back-geared motor coupled direct to a band resaw, with power feed, built by the Frank Clement Company, of Rochester, N. Y. Fig. 3 illustrates a similar motor direct coupled to a 12-in. rip saw. In the two latter cases the gear ratio chosen for the back gear on the motors

was such as to accommodate the resulting driving speed to that required by the machine. This is an excellent feature of the back-geared type of motor in avoiding belt driving.

The band resaw, Fig. 2, is driven by a 15-h.p. motor, which operates at 1,100 rev. per min., but delivers from the back-gear shaft at 350 rev. per min. The rip saw, Fig. 3, is driven by a 10-h.p. motor, operating at 1,000 rev. per min., but which is back-geared down to deliver at 400 rev. per min., the back-gear speeds agreeing in both cases with the speeds of driving of the tools..

In Fig. 4 there is shown a belted individual drive from a 1-h.p. slow-speed inclosed motor to a fret or jig saw, and in Fig. 5 a similar drive for a band saw built by the Frank Clement Company. The former motor operates at 1,100 rev. per min., while the latter saw, Fig. 5, is driven by a 2-h.p. slow-speed motor running at 1,000 rev. per min.

Fig. 6 illustrates another back-geared motor drive direct-coupled to a band resaw, built by Fay & Egan, Cincinnati, Ohio. The motor in this case is a 7½-h.p. inclosed floor-type motor, which runs at 750 rev. per min., but is back-geared down to deliver at 350 rev. per min.

The motors used in this installation are the well-known inclosed slow-speed, multi-polar motors, with laminated poles, manufactured by the Triumph Electric Company, which were

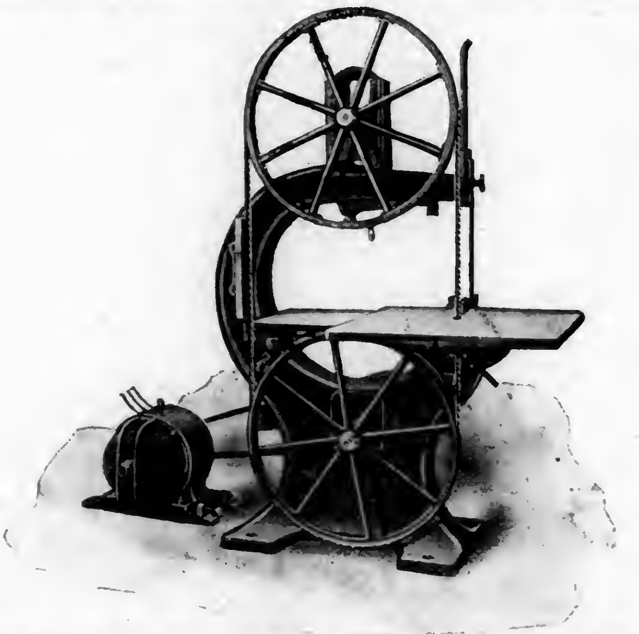

FIG. 5.—BELTED DRIVE FOR A BAND SAW FROM A 2-H. P. MOTOR.

illustrated and described on page 361 of our November, 1900, issue. They are all fitted with self-oiling bearings, carbon brushes and are designed for a minimum of sparking; the result aimed for in the general design of this motor is to render it absolutely reliable and as free as possible from repairs.

REDUCED CLEARANCE IN LOCOMOTIVE CYLINDERS.

The advantages of a reduction in clearance of steam engines are generally admitted. Many attempts have been made to adapt the principles of the Corliss valve motion for application to locomotives. These have all failed to attain practical success. They have usually consisted in the application of an entirely new valve motion with added complication. Mr. Ira C. Hubbell, in a paper read before the New York Railroad Club, last month discussed the effect of cylinder clearance upon the quantity of steam consumed in doing specific work and incidentally introduced the subject of the new Alfree valve gear, which is designed to effect the Corliss principle on a locomotive. This gear, however, makes use of the usual link motion and adds an attachment to the rocker arms with a connection to the crosshead. In this respect it differs radically from the attempts mentioned. It also includes an arrangement of a slide valve which permits of reducing clearance. An engine fitted with this valve gear has been running for two years and a number are now under construction for several railroads.

This valve gear stands for reduced clearance, for delayed exhaust opening and closure of the valves and for a combination of reduced clearance and such a degree of compression as to reach the initial pressure for the clearance used. It also stands for short, direct and smooth surface steam passages. In his paper Mr. Hubbell insisted that all clearance is waste and that the ideal condition with respect to economy would be one in which there is no clearance whatever. Upon this assumption he bases his predictions of steam consumption and believes that the economy will be greatest the nearer the clearance approaches to zero. The editors of this journal do not consider this opinion correct, but they believe that a mechanically satisfactory valve gear which will delay exhaust closure in such a way as to properly fill a correct volume of clearance is likely to be greatly beneficial to the locomotive, especially

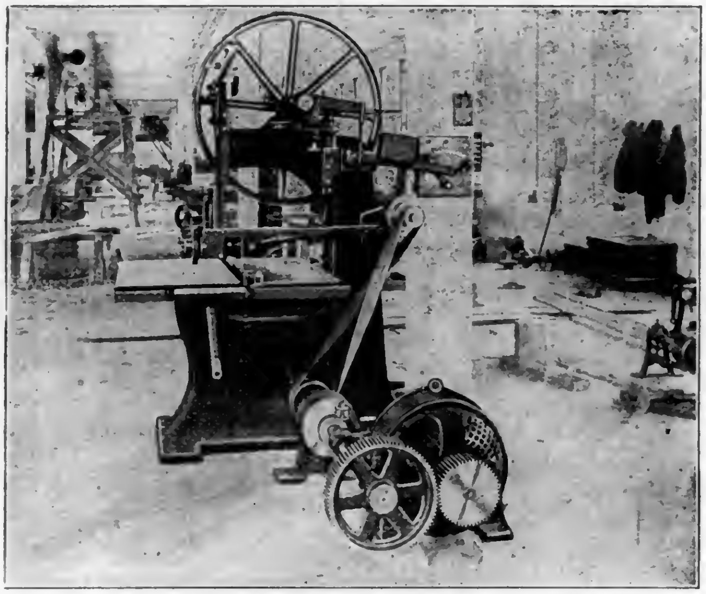

FIG. 6.—DIRECT-COUPLED DRIVE UPON A BAND RESAW,—7½-H. P. BACK-GEARED MOTOR.

if it permits of reducing clearance from 8 and 10 down to 2½ per cent.

An illustrated description of this valve gear will be presented in the near future in this journal.

CARE OF COMPOUND LOCOMOTIVES.

In discussing the care of compound locomotives before the Traveling Engineers' Association, among other things Mr. A. L. Beardsley said:

"Those of you who are familiar with some makes of compound locomotives have during the past winter ridden over the road when it was impossible for you to see the front end of the engine, and if it had an iron cab it was covered on the inside with frost and ice. You have had steam leaks around the front end of the engine so numerous that you could not detect where they came from and which one was the worst. This steam came from high and low pressure pistons, valve stems, cylinder heads, cylinder cocks, relief valves, cylinder cock pipes, etc., and did not have a tendency to make the engineer and fireman friendly to the compound. This engine on arrival at the terminal was put in a roundhouse that was too short and the doors could not be closed. The machinist was given a list of work on it that he could not do on account of these same steam leaks, the gas and smoke in the roundhouse and the fact that he could not keep his hands warm while at work. Some of the men who care for and handle these machines lost some of that interest in their work that is so valuable to railway companies. The repairs on these large compounds have been made difficult and laborious from the fact that the facilities for doing the work are in some cases limited and the roundhouses are inadequate."

NEW LOCOMOTIVE SHOPS AT TOPEKA.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

II.

The previous article on this subject appeared on page 321 of the September number.

Before passing to the other features of this plant several illustrations should be presented. One of these shows the construction of the roof trusses in the locomotive shop. These are spaced at 25 ft. centers with a span of 74 ft. 3 ins. from center to center of posts. The steel work is heavy and is roofed with Ludowici tiling, as are also the saw-toothed portions over the side, or machinery, bays. The engraving of the truss shows the depth of the crane girders, the manner of supporting them and their height from the floor level.

Another engraving shows sections of the locomotive pits, which have already been referred to. These are built of concrete, as are all the foundations of the buildings, the machinery foundations and the ducts for the distributing system of hot air for heating and ventilating the building. One of the photographs shows a portion of a main duct and its connection to the fan room. This construction employed temporary wooden forms over which the concrete was built.

Steam, exhaust or live, is brought from the power-house to four Sturtevant fans, each 10 ft. in diameter by 5 ft. wide and of the three-quarter housed pattern. These are located outside of the main building in four fan-houses, shown on the ground plan. Each heater is capable of discharging 72,000 cu. ft. of air per minute at a speed of about 165 rev. per min. For the heating engines steam at 150 lbs. pressure is supplied. Each heater has 9,000 linear feet of 1-in. pipe, and discharges into the underground ducts. The following figures represent the heating problem:

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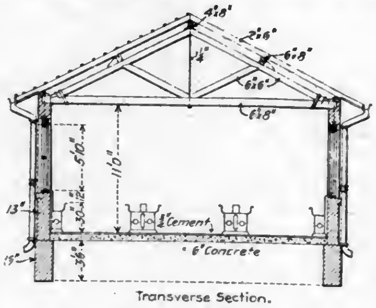

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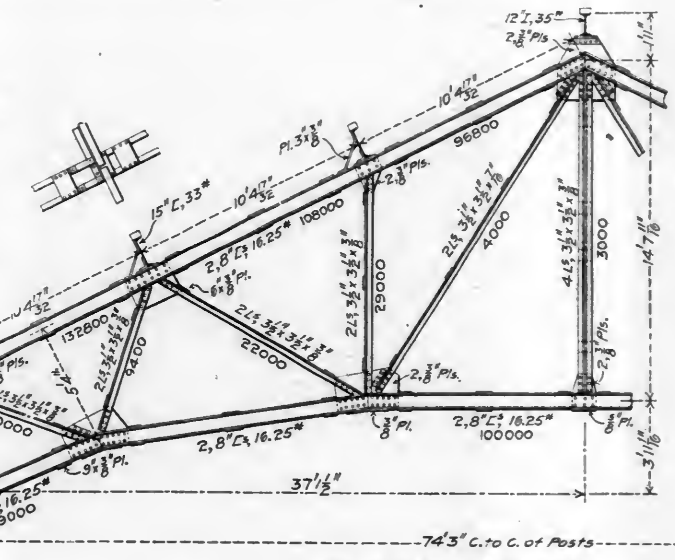
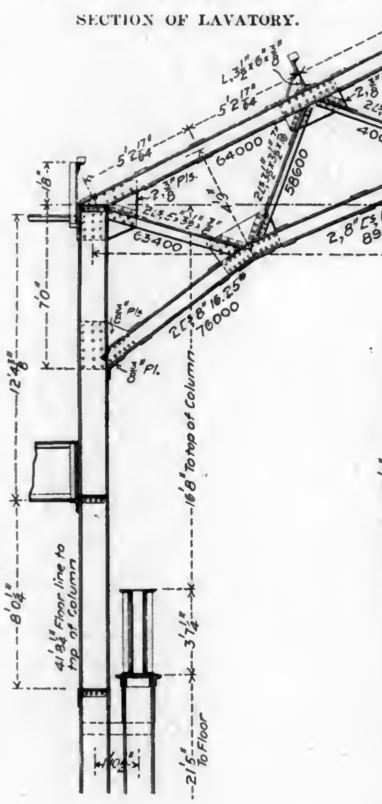
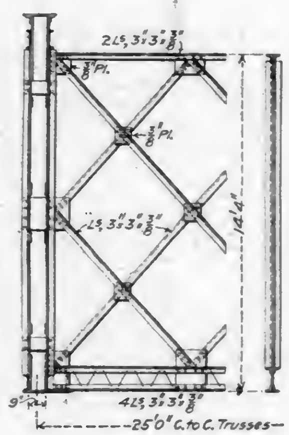
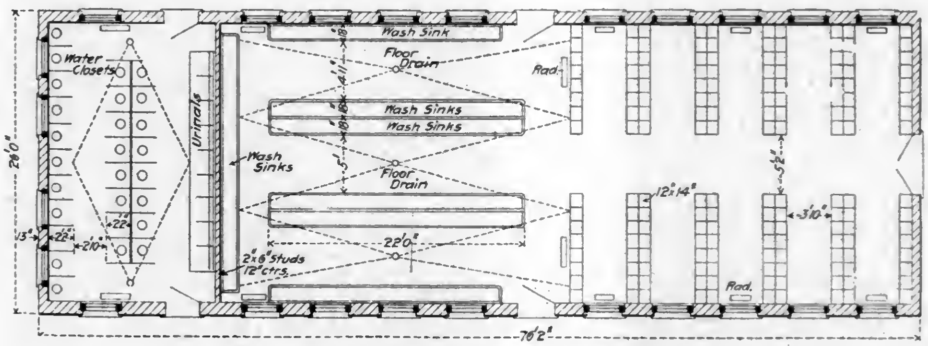
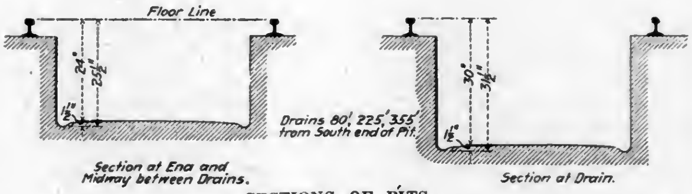




ONE OF THE ROOF TRUSSES.



PLAN OF ONE OF THE LAVATORIES.



SECTIONS OF PITS.

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NEW LOCOMOTIVE SHOPS AT TOPEKA—ATCHISON, TOPEKA & SANTE FE RAILWAY.

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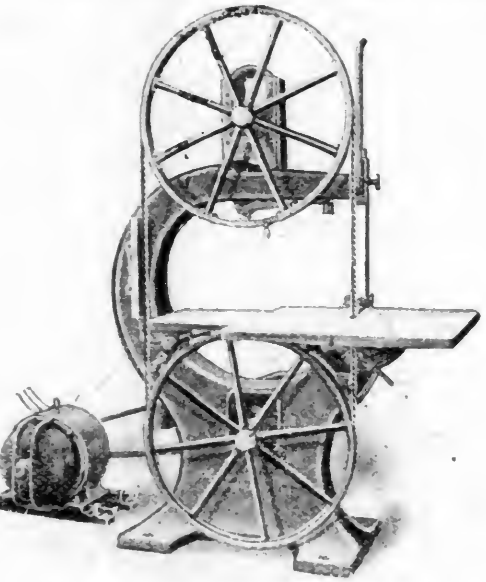

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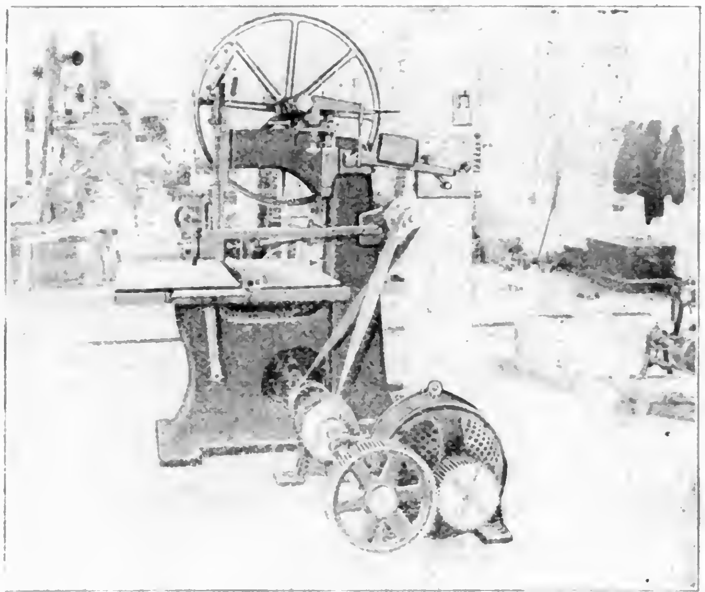

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Atchison, Topeka & Santa Fe Railway.

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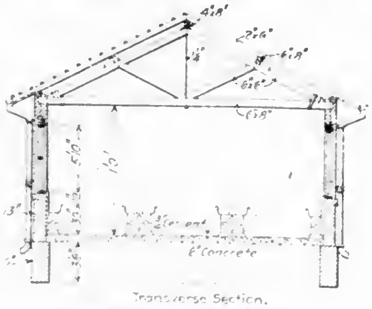

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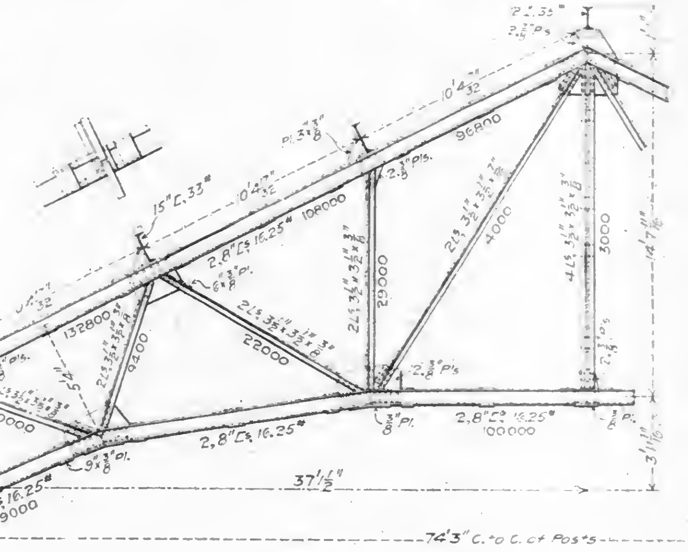
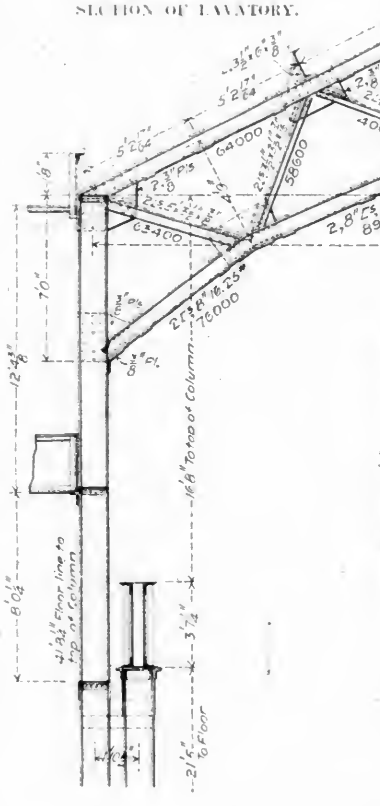
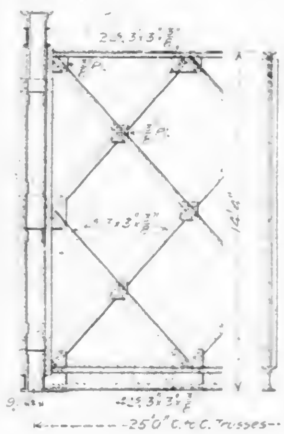
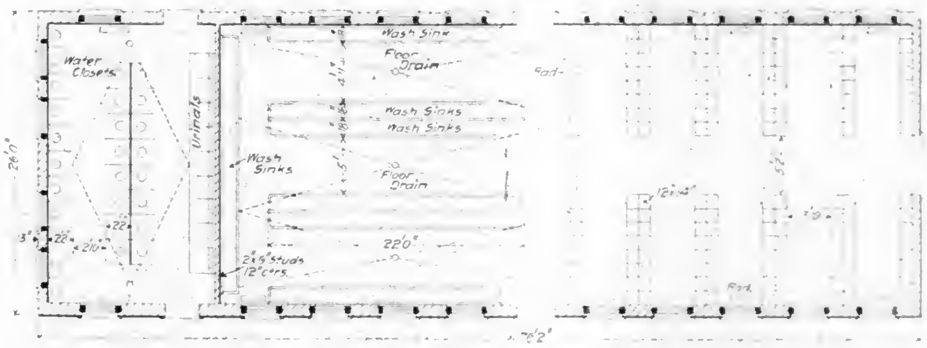
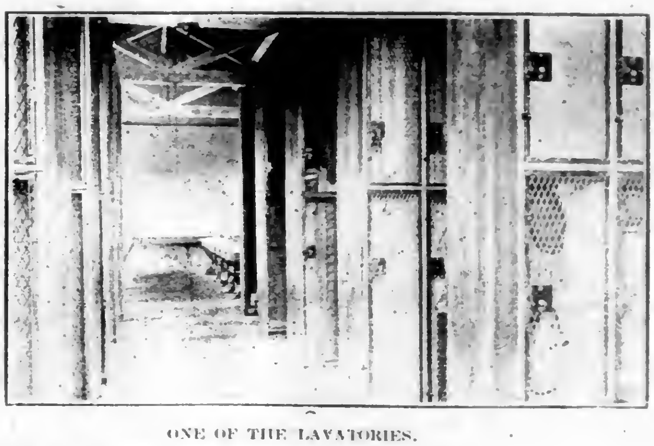




ONE OF THE ROOF TRUSSES.



PLAN OF ONE OF THE LAVATORIES.

SECTIONS OF PITS.



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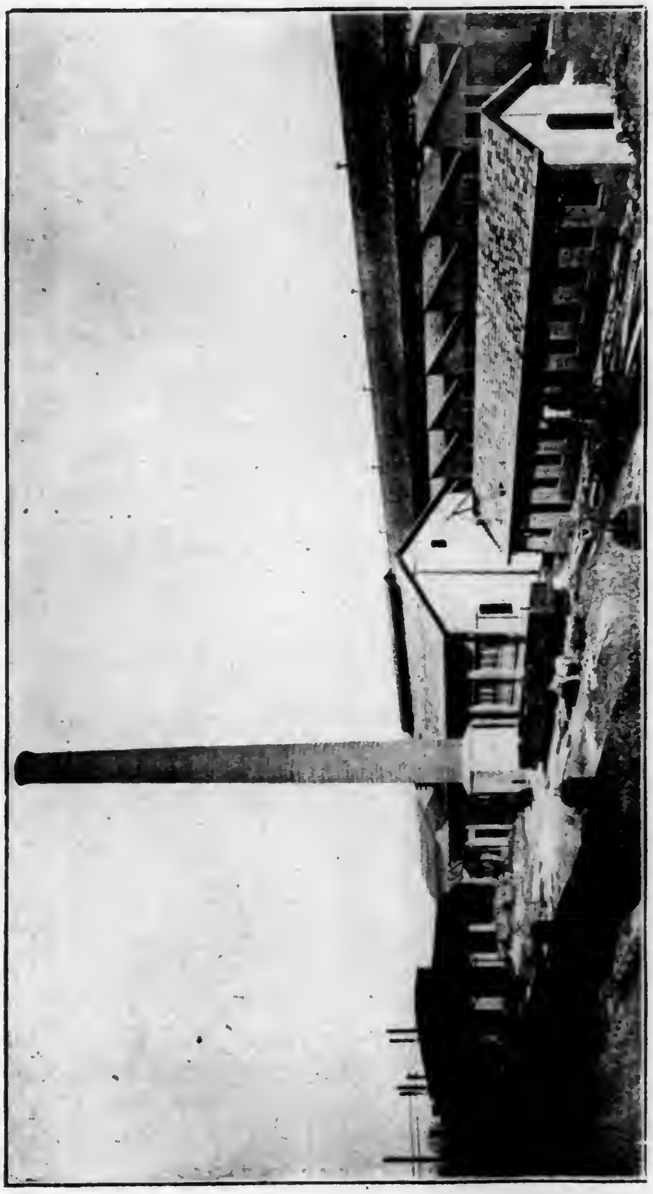
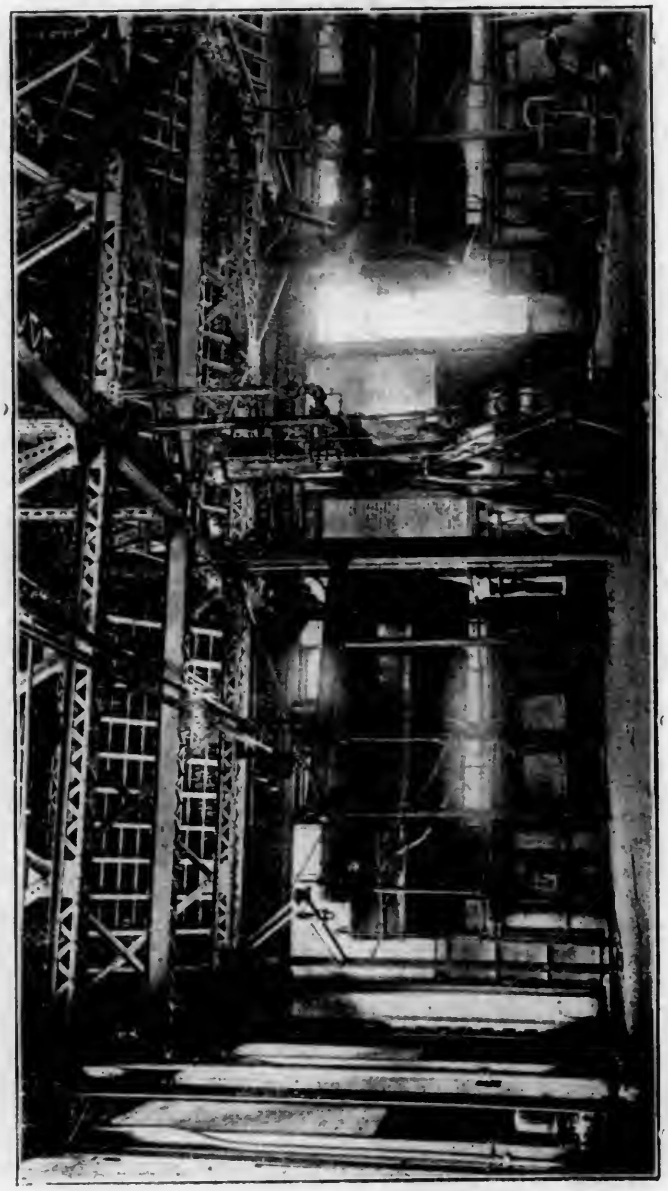
NEW LOCOMOTIVE SHOPS AT TOPEKA—ATCHISON, TOPEKA & SANTE FE RAILWAY.



BLACKSMITH SHOP—POWER HOUSE—WEST SIDE OF LOCOMCTIVE SHOP.

CONSTRUCTION VIEW OF A HEATING CONDUIT IN LOCOMOTIVE SHOP.



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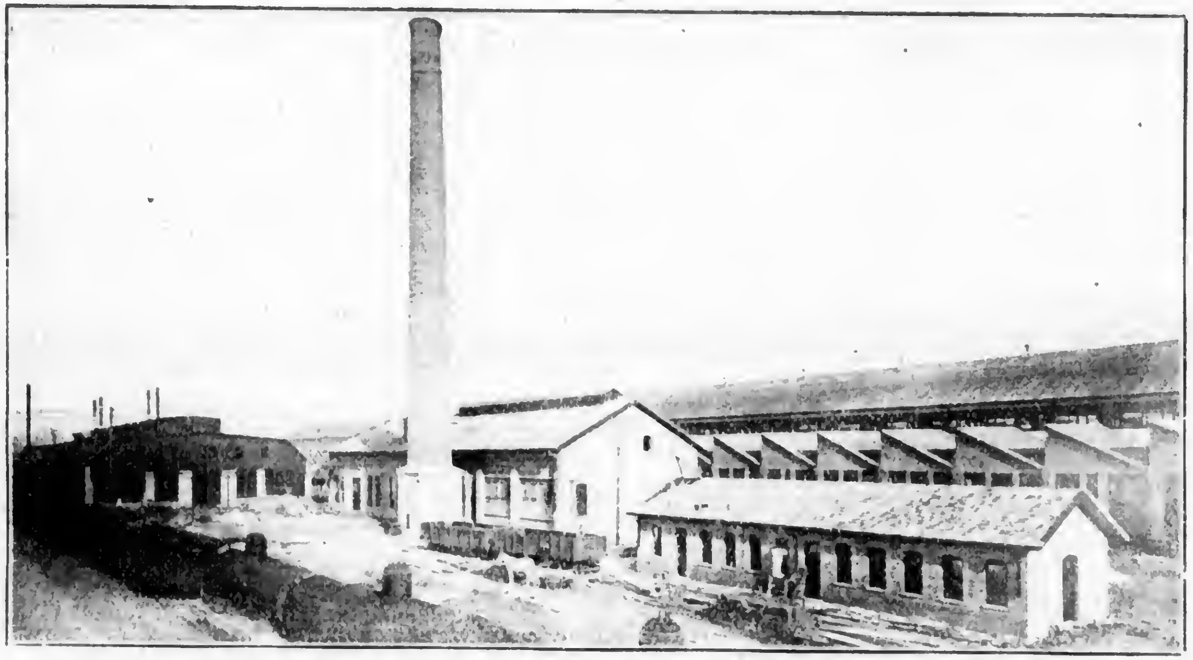

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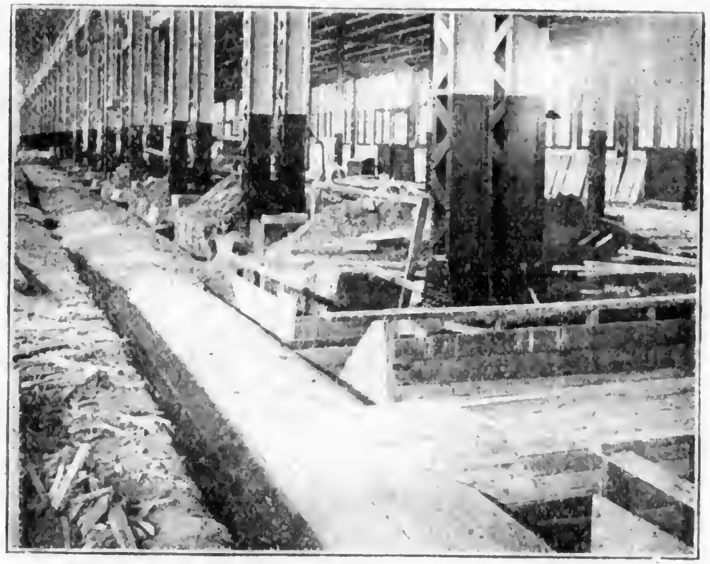

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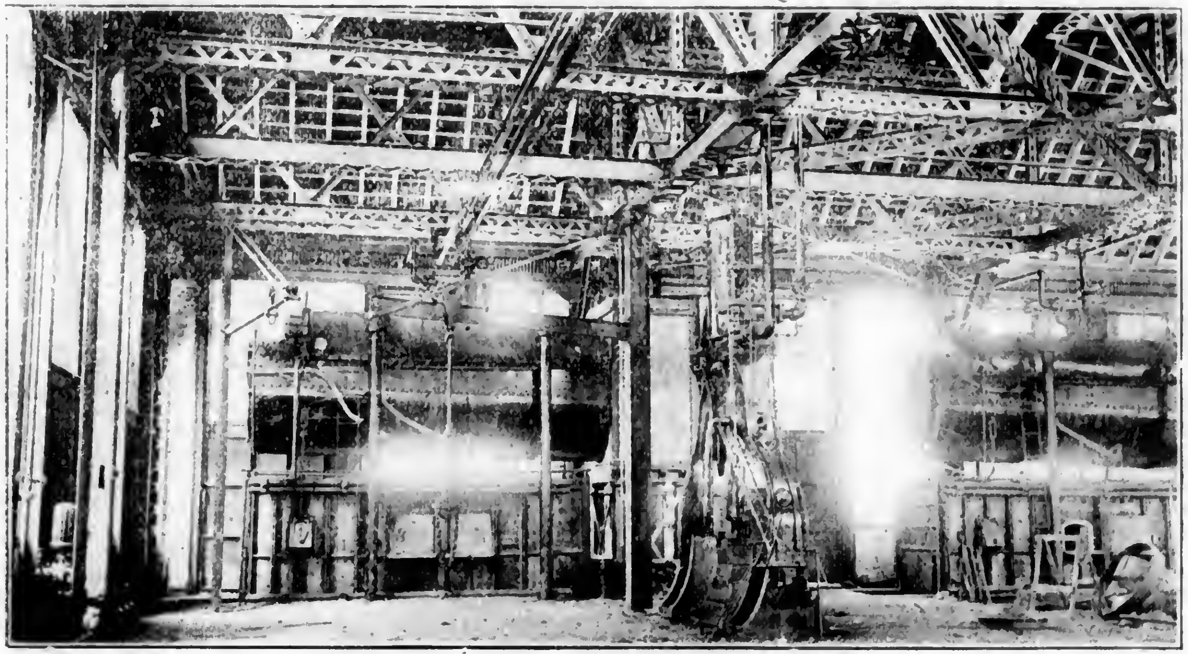

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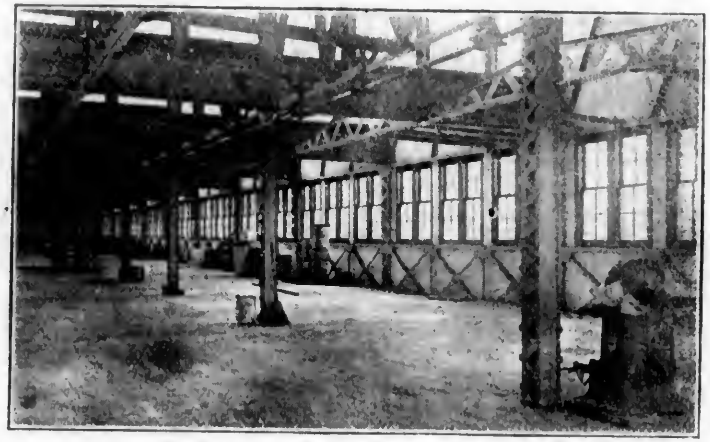

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MOTOR-DRIVEN MACHINE TOOLS.

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To perform the work, the machine is lifted by a crane and placed exactly in the center of the motor yoke and rigidly clamped at the base to the T-slotted floor plate, to which the yoke is also bolted fast. The center line of the spindle in its horizontal position runs exactly through the center of the column and all horizontal holes drilled in concentric surfaces will therefore be drilled in line with the center.

The spindle has a positive feed with four changes, has a quick return arrangement and is back-geared direct from the spindle-driving gear. The back-gear can be thrown in and out when the machine is running.

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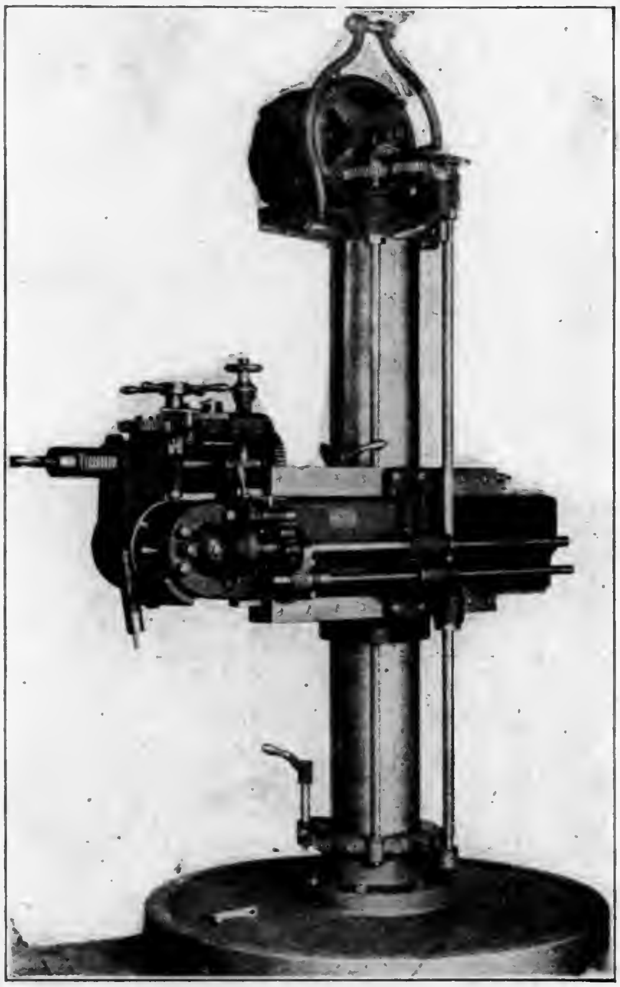
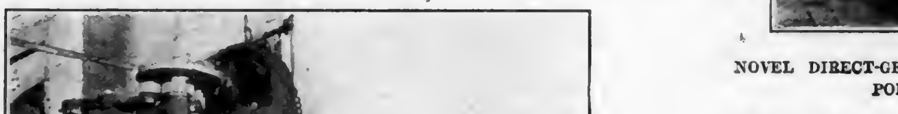


NOVEL DIRECT-GEARED DRIVE (BULLOCK MOTOR) UPON A SPECIAL PORTABLE RADIAL DRILL.—ROOS & MILL.



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The arm of this drill is made in two gates, each 4 ft. long, the extreme distance to which the spindle will drill being 238 ins. The saddle has a vertical adjustment of 54 ins. and the spindle has a traverse in the saddle of 20 ins.

The motor, which is a 2-h.p. constant-speed direct-current Westinghouse motor operating at 1,200 revolutions per minute, is, as is clearly shown in the engraving, mounted upon a small bracket at the top of the upright from which it drives the spindle through a bevel reduction gearing, and also operates the elevating mechanism for the entire arm. The commendable features of this arrangement speak for themselves.

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In addition to the large number of special features which this tool has incorporated in its design, may be mentioned the drill speed index plate, located on the motor, which indicates the proper arrangements of speed box levers for all sizes of drills, and in cast iron or steel, with the spindle back-gear in and out.

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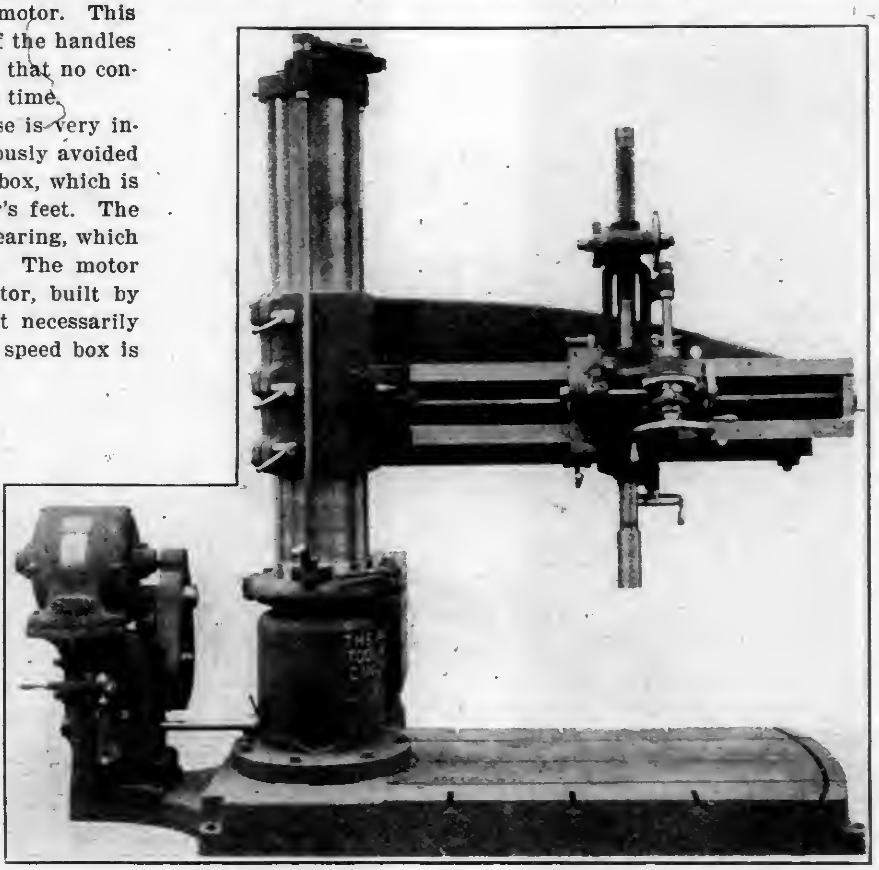

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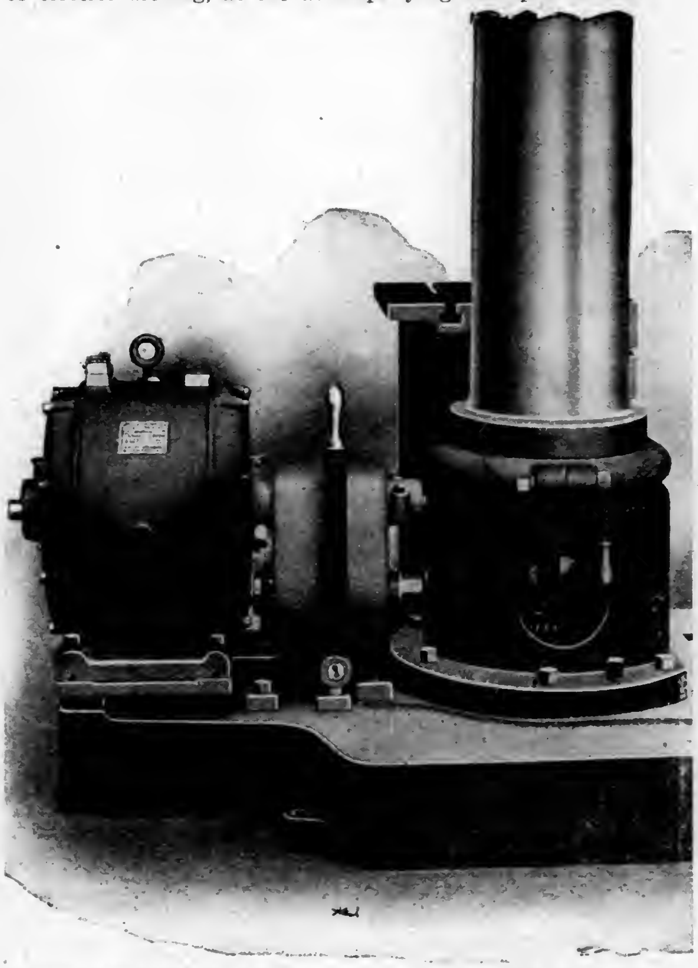
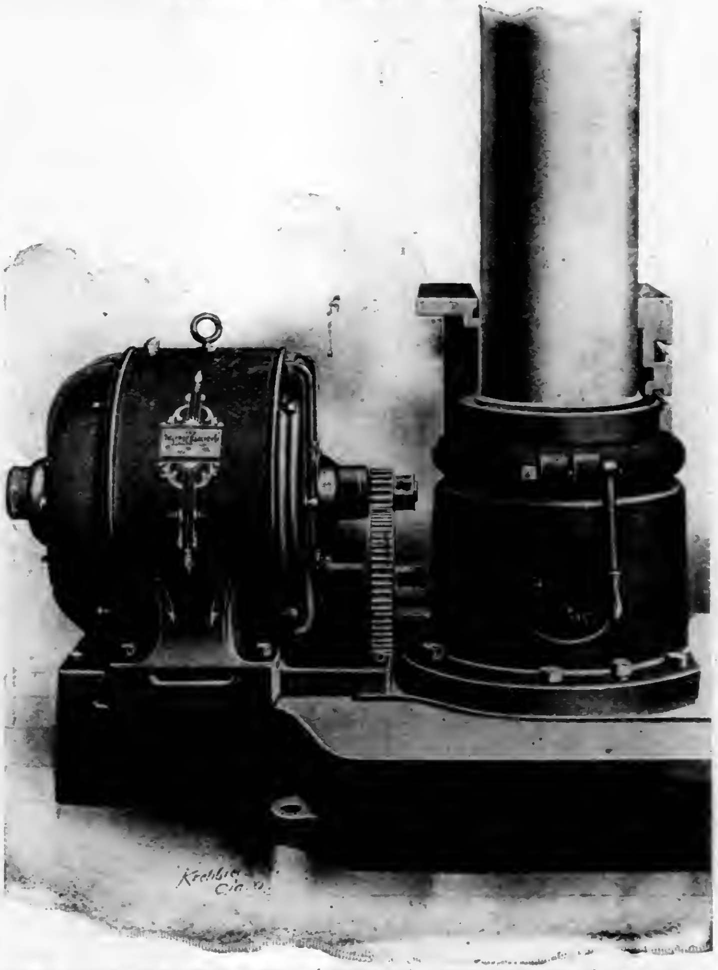


GEARED CONSTANT-SPEED DRIVE (STYLE A) UPON THE NO. 1 RADIAL DRILL.—WESTINGHOUSE INDUCTION MOTOR.



GEARED VARIABLE-SPEED DRIVE (STYLE E) UPON THE NO. 1 RADIAL DRILL.—TRIUMPH ELECTRIC COMPANY'S MOTOR WITH FIELD CONTROL.

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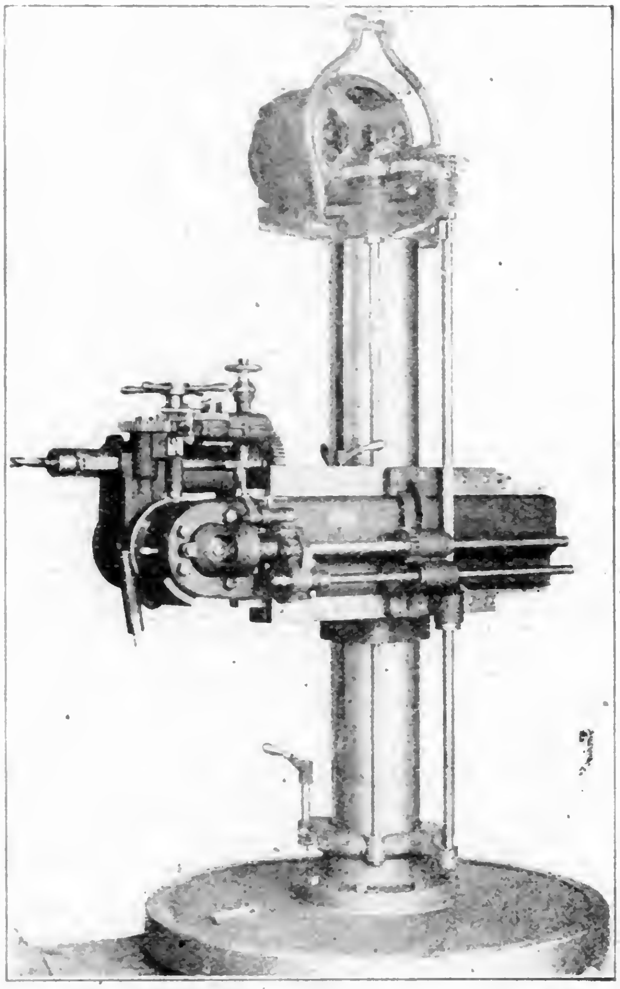

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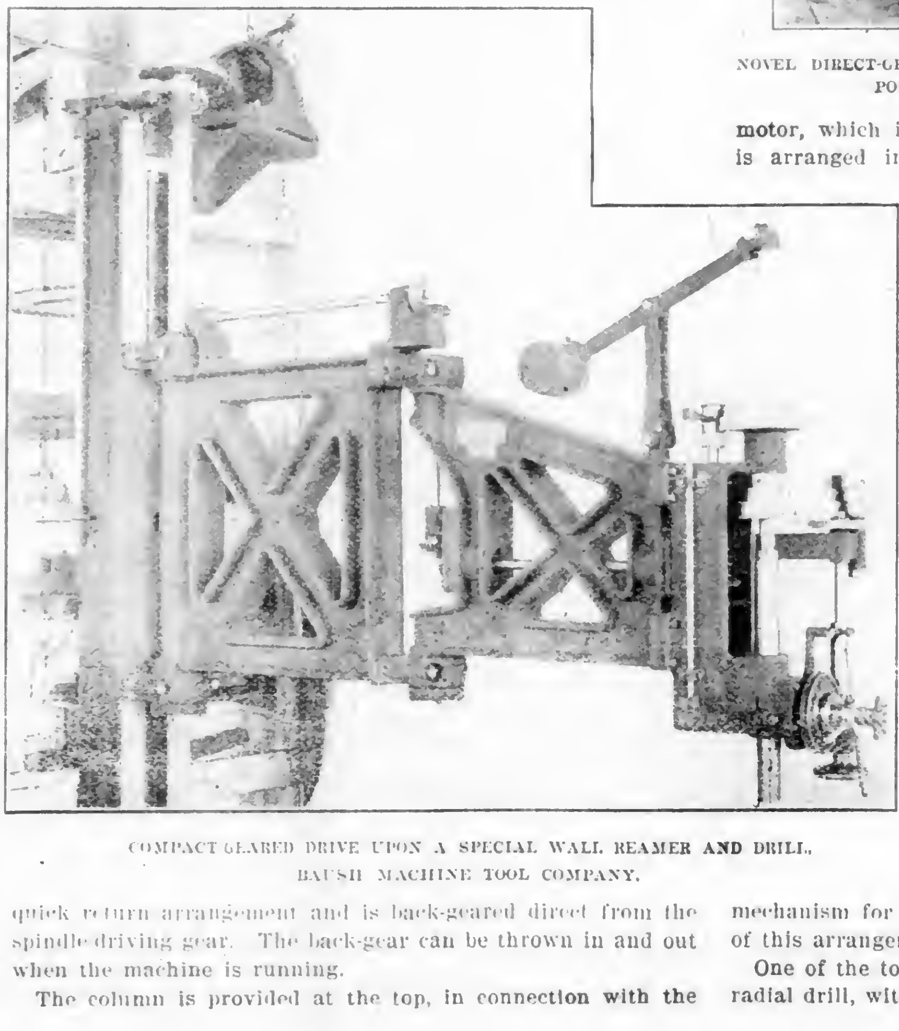

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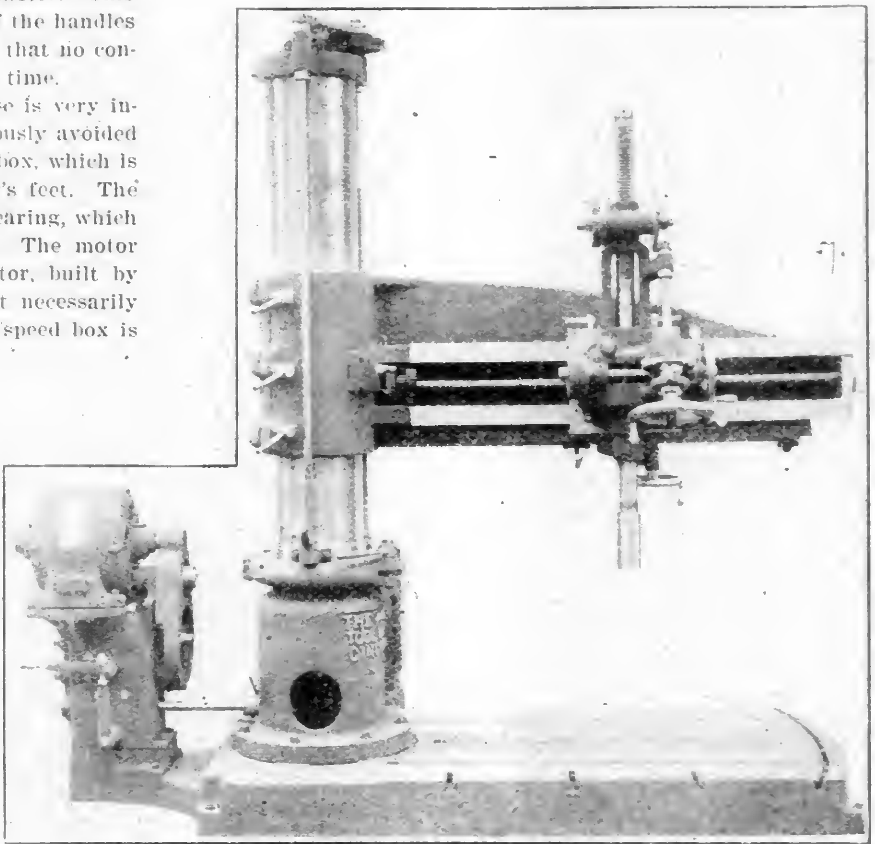
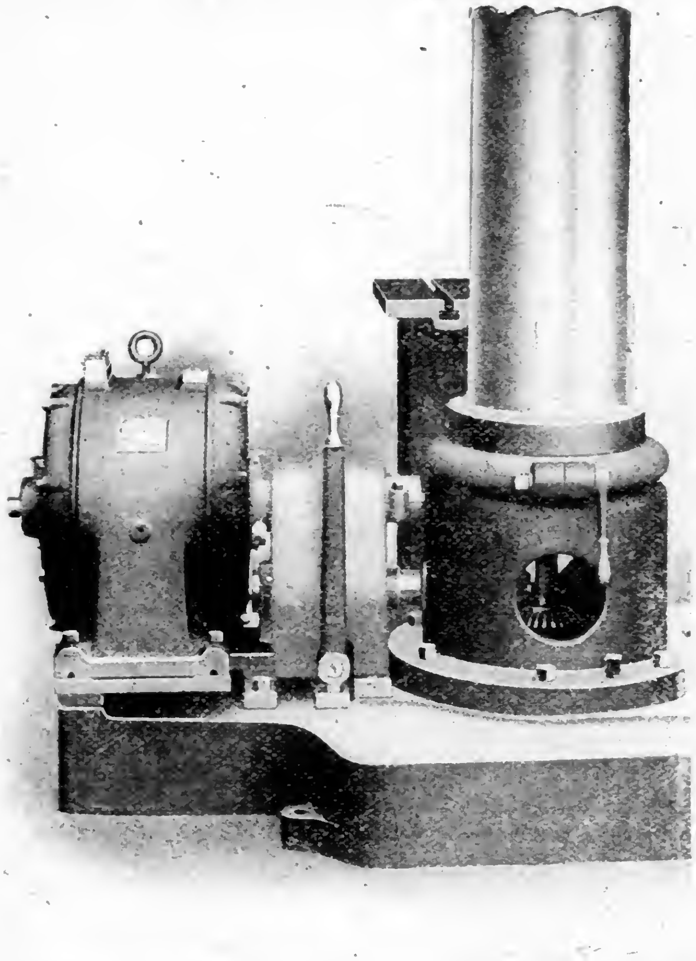
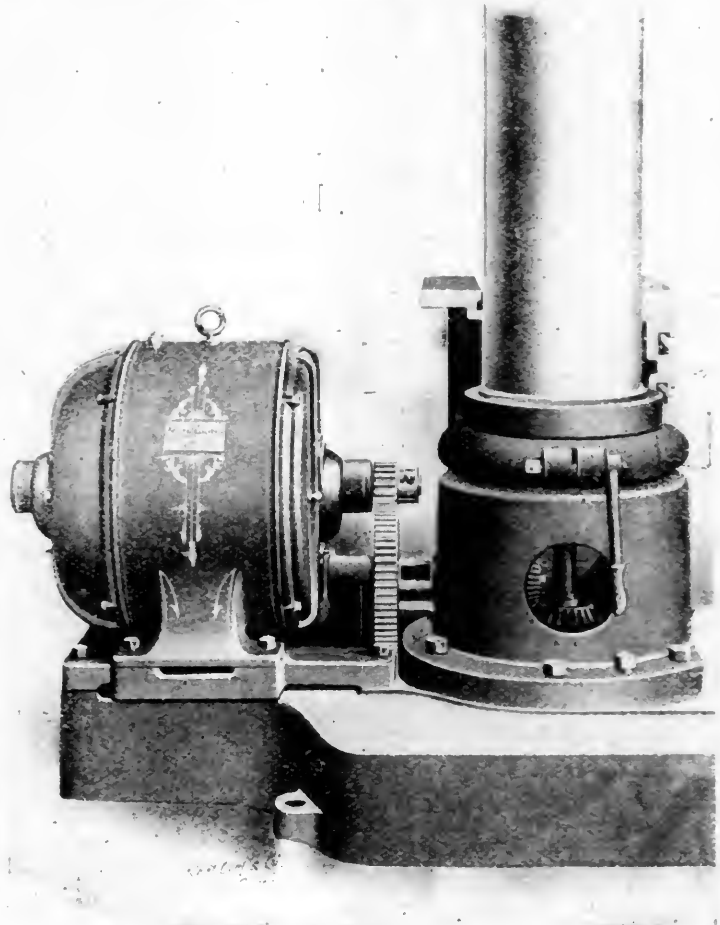


DIRECT-GEARED CONSTANT-SPEED DRIVE UPON A 5-FT. RADIAL DRILL.—AMERICAN TOOL WORKS COMPANY.



GEARED CONSTANT-SPEED DRIVE (STYLE A) UPON THE NO. 1 RADIAL DRILL.—WESTINGHOUSE INDUCTION MOTOR.



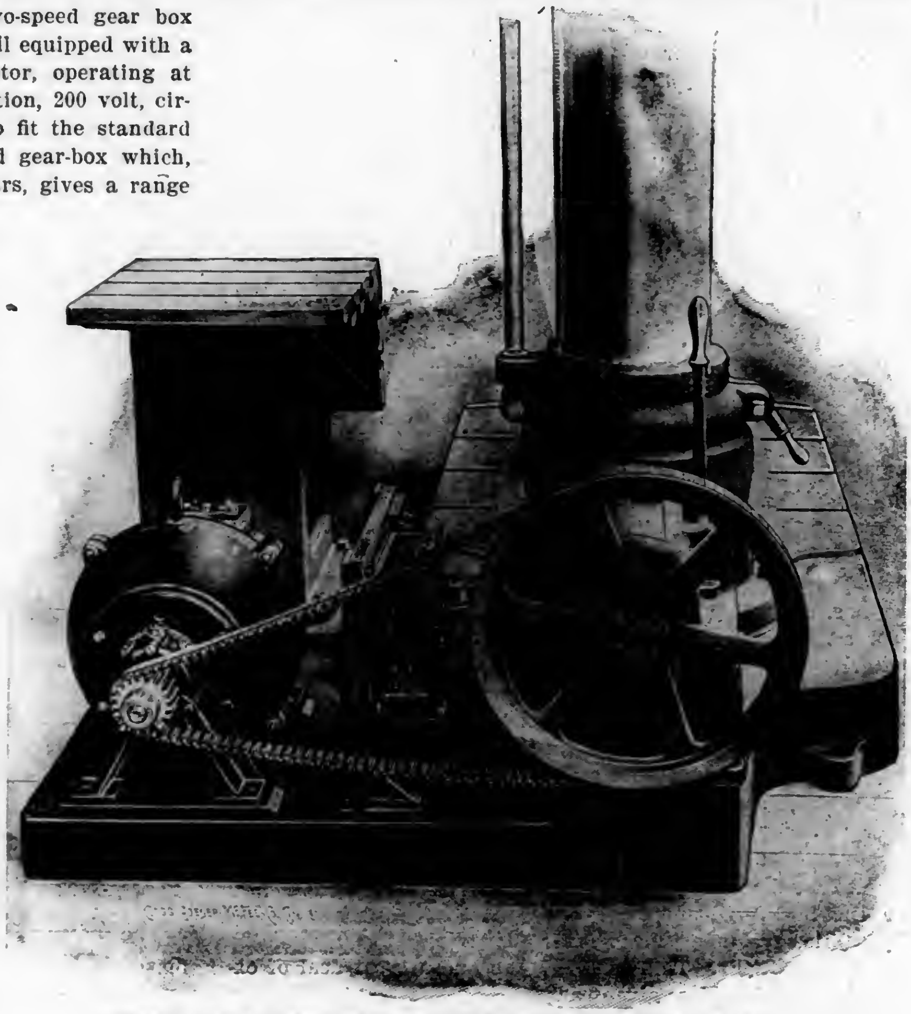
GEARED VARIABLE-SPEED DRIVE (STYLE E) UPON THE NO. 1 RADIAL DRILL.—TRIUMPH ELECTRIC COMPANY'S MOTOR WITH FIELD CONTROL.

BICKFORD DRILL & TOOL COMPANY.

speed motor used in connection with a two-speed gear box on the drill. This tool is the No. 1 radial drill equipped with a 3-h.p., Type C., Westinghouse induction motor, operating at 710 rev. per min., on a 2-phase, 3,000-alternation, 200 volt, circuit. The motor sets on a bracket made to fit the standard drill base and operates through a two-speed gear-box which, in conjunction with the four-speed back gears, gives a range of eight speeds, varying in geometrical progression from 46 to 176 rev. per min.

The above drive is not, however, to be generally recommended, as it is limited in speed range to only eight speeds; for use where a constant speed alternating-current motor must be used, it offers many advantages—this is a condition that is often met and is in this case well provided for.

The drive illustrated on this page, which is termed their style D drive, is more generally applicable, as it is arranged for direct current. This tool is also the No. 1 Bickford radial, and is equipped with a 3-h.p. Lundell constant-speed direct-current motor, mounted on an extension of the base. The drive is through a silent chain to the sprocket on the speed box, which in this case is the well-known 4-speed main driving mechanism which is used on the Bickford drills—this device was fully described on pages 178 and 179 of our May, 1903, issue. By means of this mechanism and the 4-speed back gear on the rear of the arm, 16 speeds are available at the spindle. As may be noted from the engraving, in this drive the motor starting box is located on the tool between the motor and speed box, making the tool and its drive entirely self-contained and capable of portable use in a shop.



SILENT CHAIN CONSTANT-SPEED DRIVE (STYLE D) UPON THE NO. 1 RADIAL DRILL.—BICKFORD DRILL & TOOL CO.

On page 381 is illustrated the style E drive of the Bickford Drill & Tool Co. This is stated to be their cheapest and best method of variable-speed driving, as the motor speeds are varied by field control, which is

AN INTERESTING ARRANGEMENT OF CONE-PULLEY COUNTERSHAFT FOR USE WITH A CONSTANT-SPEED MOTOR.—DESIGNED BY BEAMAN & SMITH.

the more efficient method. In this drive the main-drive speed box is left off, as it is unnecessary.

This tool is also the No. 1 radial drill, equipped with a 3-h. p. variable-speed motor, built by the Triumph Electric Co., Cincinnati, O. It is mounted on an extension of the base, and the power is transmitted to the gear box by means of two spur gears and a raw-hide pinion which, after proper adjustment of the number of teeth in the pinion to suit the speed of the motor with which it is to be used, will furnish a correct range and gradation of speeds for all sizes of drills given on the standard Bickford speed-plates.

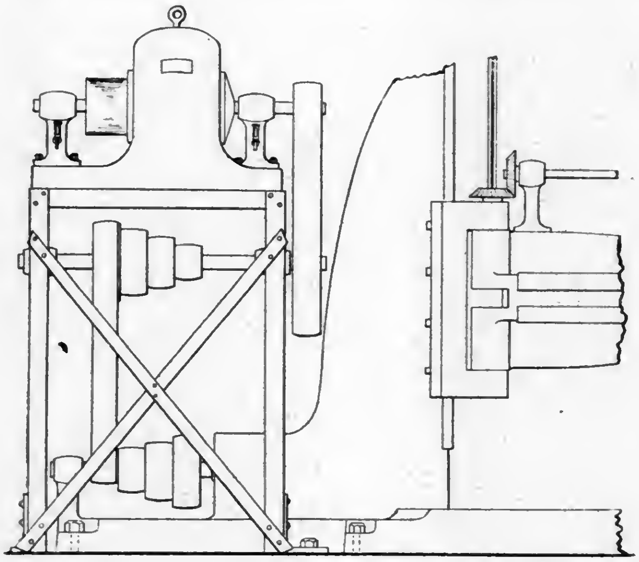
The two following engravings illustrate methods of mounting cone pulleys for use in connection with constant-speed individual drives, which have been used with marked success under conditions where any other arrangement would have been impossible.

The former is a view of a special A frame support that was designed by Beaman & Smith, Providence, R. I., for use upon one of their large horizontial-spindle drilling and boring machines. The conditions were such that it was necessary to mount the cone pulleys on the tool at the rear of the spindle column, and this arrangement provided for mounting them vertically without bringing the cone centers too close.

The A frames are of cast-iron, well braced, at the top of which is mounted the countershaft, which is driven by belt direct from the motor and carries the driving cone. The cone upon the tool's drive is directly beneath the countershaft cone. There is also a wide face pulley upon the countershaft from which is driven, through a belt shifter arrangement, the mechanism at the rear for raising and lowering the spindle saddle upon the column. The motor used in this drive is a 5-h.p., C & C. constant-speed, 220-volt, direct-current motor.

The remaining engraving shows a sketch of a motor mount that is in use at the Baldwin Locomotive Works, upon an individual drive that has been applied to a Niles radial drill. A large number of tools have there been equipped for electric driving, this example being one of the neatest arrangements to be found for constant-speed driving.

As may be seen from the sketch the stand is built up of angle-iron framing and is well braced. It rests on the floor independent of the drill and supports the motor, a Westinghouse constant-speed direct-current machine, upon the top. The motor drives the countershaft which is immediately below



MOTOR AND COUNTERSHAFT SUPPORT USED ON A CONSTANT-SPEED DRIVE FOR A RADIAL DRILL AT THE BALDWIN LOCOMOTIVE WORKS.

it, from which the drive of the tool is derived, as shown. This arrangement is very satisfactory, in spite of the closeness of pulley centers, and gives plenty of head room for cranes and take up almost no extra floor space.

ATTITUDE OF PRODUCERS TOWARD SPECIFICATIONS.

Dr. C. B. Dudley, of the Pennsylvania Railroad, presented a valuable paper upon "The Making of Specifications" before the American Society for Testing Materials, from which the following paragraph is quoted:

"We are well aware that many producers object to specifications on the ground that they are annoying and harassing, and really serve no good purpose. On the other hand, we are able to say that some manufacturers have asked that specifications be prepared, and one large producer indeed told us in conversation that the more difficult the specification the better they liked it, on the ground that it limited the competition which they would have in producing the product. There is a point here which is perhaps worth a few words. Let us suppose that an honest manufacturer is making a good product. He understands his business and has good facilities and is turning out an excellent article. When he comes to sales he is called upon to meet in competition, let us assume, those who are not equally well equipped, and who in order to secure a market must offer lower prices. In order to recoup for this diminution in price he, of course, must make an inferior product. So long, therefore, as the consumer buys on price alone, and without any specification or examination of shipments, the honest, competent manufacturer is at a disadvantage. On the other hand, if there is a good, workable specification in force and each shipment is examined, the unfair competition of the inferior manufacturer is entirely eliminated. We have many times stated in conversation with manufacturers that in our judgment those who are doing a legitimate, straightforward, honest business should be the strongest friends that specifications have, and it is gratifying to be able to state that many manufacturers of commercial products look at the matter in this light."

COMMUNICATIONS.

A SUGGESTION WITH REFERENCE TO THE "AMERICAN ENGINEER" TESTS.

To the Editor:

As the result of a careful study of Professor Goss' report upon the AMERICAN ENGINEER tests of locomotive draft appliances, which is concluded in the current issue of your paper, I have no hesitation in characterizing this report as a record of one of the most ably conducted and practically valuable investigations in scientific locomotive engineering which has ever been carried out. It is alike worthy of Professor Goss and of the AMERICAN ENGINEER, to whose liberality and initiative these tests owe their existence. The report is a classic in its special department of science, but it is feared that in the future there will be many persons desirous of utilizing it, to whom the complete series of numbers of the AMERICAN ENGINEER containing the report will not be available. It is probable that this report will be of interest and value so long as the present type of steam locomotive exists, and in order that it shall be for all time readily available for reference and study, I beg leave to suggest through your columns to the executive committee of the Railway Master Mechanics' Association that, with your permission, this report be made of permanent record by publication next year in the proceedings of the association. EDWARD L. COSTER,

Honorary Member Master Mechanics' Association.

25 Broad Street, New York, September 8, 1903.

SIDE BEARINGS FOR TENDERS.

To the Editors:

From what I can learn, the majority of railways never use any side bearings on the front trucks of tenders. I have looked this matter up, but have been unable to find any good reason for this established practice. I take the liberty of asking or suggesting that some time in the future you will give an article in your journal discussing the matter. I feel sure that others are in the dark on this question and that we will all be mutually benefited by it.

J. P. CALLIGAN.

Marshall, Texas.

Many railroads use side bearings on the leading trucks of tenders. Others have used and abandoned them, but with the advent of satisfactory roller and ball side bearings the practice will undoubtedly become general.

Side bearings of the usual type increase the difficulty of curving. Tenders are usually short, and it is possible for the side bearings on the rear trucks to prevent the rocking of the tender. Furthermore, the rear truck carries the greater part of the load. These are undoubtedly the reasons for the apparent abandonment of side bearings on front trucks which our correspondent has noted. They have not been abandoned, and are likely to appear in larger numbers in the future.—EDITORS.

THE BORING MILL THAT BROKE DOWN.

To the Editor:

I was much interested in the experience, noted on page 267 of the July issue of the AMERICAN ENGINEER (editorial correspondence), with a 96-in. boring mill at a large railroad shop, which proved to be "not strong enough." The case cited was one that does not speak well for the machine-tool builders, and moreover it brings up a subject that deserves more attention than it usually receives.

If correctly designed, the driving belt of a machine of this kind should be the weak point; and the belt should slip, even if quite tight, before the gears should break. But it is not surprising that this mill broke down. There were three things which especially contributed to the breakage:

First, the 10-h.p. motor—as usually designed for average work, boring mills of this size require about 3½ h.p. to drive, or, in extreme cases, 5 h.p. might be needed if the belt were kept very tight.

Second—five tires had already been bored before the "last straw." Now, it is safe to guess that the tool had become somewhat dulled, and it does not take much dulling when turning tire steel to cause a demand for double the power, or more, than when the tool is sharp. With the cutting tool in good condition and working with a feed of ¼ in. and a depth of cut of 3-16 in., the power required would probably not be less than 5 h.p. for such material. This, with a tool considerably dulled, may have increased to 10 or 12 h.p. Under such conditions a belt would ordinarily have slipped on most

tools and forced a regrinding of the tool; but upon a good motor considerable additional load may be placed before it will lay down—in this case the motor held up and the gearing failed.

Third—the operator's ambition to "pile up tires," which, while we must commend it, was undoubtedly unfavorable, and if he had reground that tool, he would probably have spared the mill.

A word about those speeds: A range of 16 to 975 ft. per minute is a ratio of about 61 to 1; or, with a given cutting speed for the maximum diameter of 96 ins., the minimum diameter for same cutting speed would be 1.6 ins., approximately. This is a somewhat greater range than usual, and more than necessary, but not much more than some users demand. It is seldom that such an extreme range is needed, but sometimes a buyer thinks it necessary and "kicks" if he doesn't get it. I have seen 2-in. holes bored on a 10-ft. boring mill. As you stated, however, such a range seems unnecessary in this case, and it does look as though something were a little bit out. J. C. Steen.

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This new inspection locomotive was recently built at the Allston shops of this road and will be used by officials. The locomotive is an old one rebuilt, and is more powerful than those usually used in such service, being capable of hauling three heavy cars if necessary. A large 12 x 9-ft. observation room is provided over the boiler, and back of this are the engineer's cab and fireman's compartment. Special insulation was provided over the boiler to keep the observation room cool and the ventilation, by aid of a pneumatic fan, is unusually effective. Air ducts through the ceiling carry the outgoing air to the hood back of the car, fresh air being introduced through a regulating box in front. An Edwards equipment supplies current for an electric headlight and incandescents in the observation room and cab, as well as under the running board. The engine has the Westinghouse high-speed brake and also "straight air," with shoes on all the wheels. Throughout, the equipment is very complete. In the following table the chief dimensions are presented:

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Driver wheel base	93 ins.
Total wheel base, including tender	42 ft. 11 ins.
Cylinders	16 by 22 ins.
Drivers	60 ins.
Weight on drivers	50,000 lbs.
Total weight	78,000 lbs.
Boiler pressure	130 lbs.
Diameter of boiler	50 ins.
Total heating surface	1,048 sq. ft.
Grate area	16 sq. ft.

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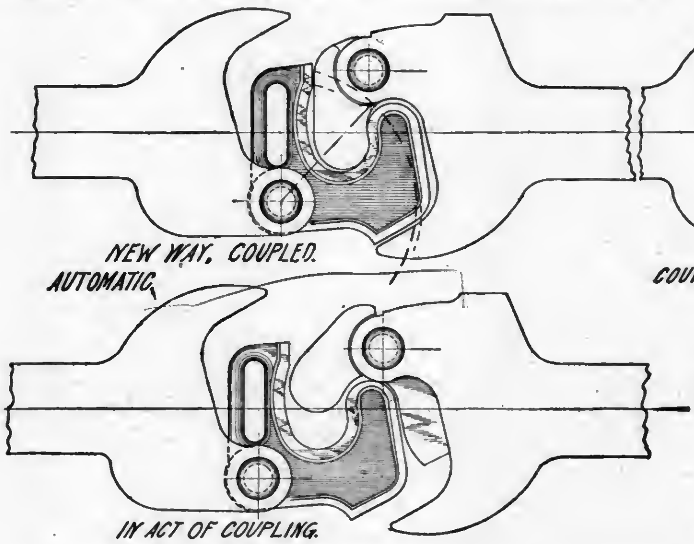
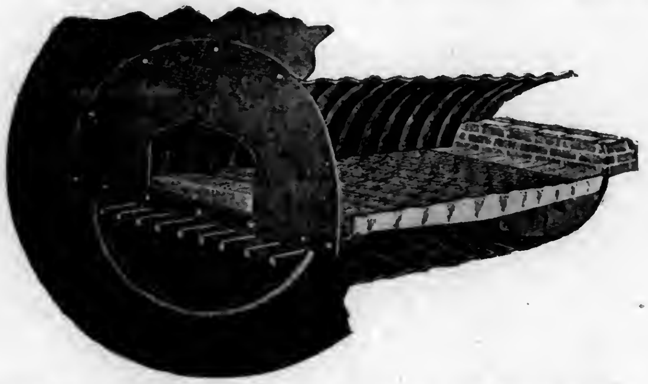


THE ST. JOHN GRATE BAR.

The improved construction of grate bars which is embodied in the St. John grate bar has proved very successful in service in marine and stationary steam boilers. It is used on four United States naval cruisers and five battleships, as well as on steamers of the American Line and other lines.

The bars are rocked singly and independently by means of their projecting ends and are rocked alternately. By shaking the bottom of the fire evenly the clinker is carried to the ash pit as soon as possible instead of forcing it upward through the fire. The cutting effect is produced by the side cutting edges as well as the crests of the corrugations, the large surface of the fire not being disturbed as is the case with bars having a large lifting effect. By this construction a large air space is provided, which benefits the fire and increases the life of the bars. As these are trussed, they are strong and not liable to warp. It is stated that by using these grates a lower grade of fuel may be burned and the frequency of cleaning fires largely reduced. Clinker does not fasten itself to these grates and this is in itself a reason for long life, as well as economy of fuel.

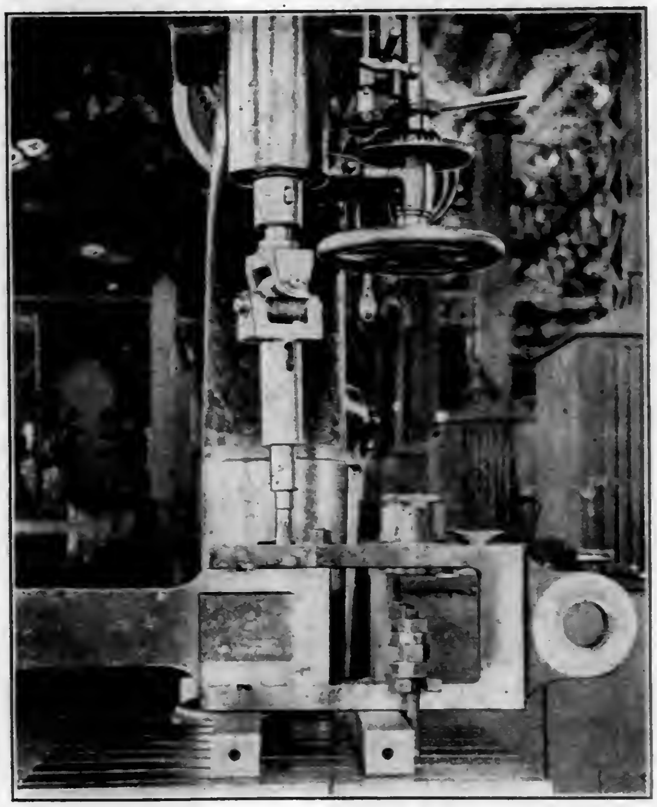


THE ST. JOHN GRATE BAR, AS APPLIED TO A MARINE BOILER.

The engraving illustrates the application to a marine furnace, where the qualities of grates are more severely tested than in any service, except possibly that of locomotives. This is unquestionably a good grate bar. Further information may be had from Mr. A. B. Willoughby, selling agent of the St. John Grate Bar Company, Machinery Department, The Bourse, Philadelphia, Pa.

REAMING ATTACHMENT FOR ROD STRAPS.

At the Albuquerque shops of the Santa Fe, Mr. W. L. Essex, general foreman, showed the writer an excellent device for reaming holes for rod strap bolts. The expense of reaming these holes by hand led to experiments upon driving the reamer by power in an ordinary drill press. In such work it is essential that the reamer should "float" and be unrestrained and free from constraint of the machine as to alignment. This is provided in this attachment by a universal joint, the construction of which is clearly seen in the accompanying engraving. The upper and lower shanks of the jointed part fit the spindle of the machine and the reamer with the usual tapers. Special care in leveling the rod does not seem to be at all necessary, and the results are all that may be desired. The drill press is made ready and the work set up in about ten minutes. It then requires about fifteen to twenty minutes to ream a hole. Doubtless this time will be very much reduced as the men become accustomed to the work.



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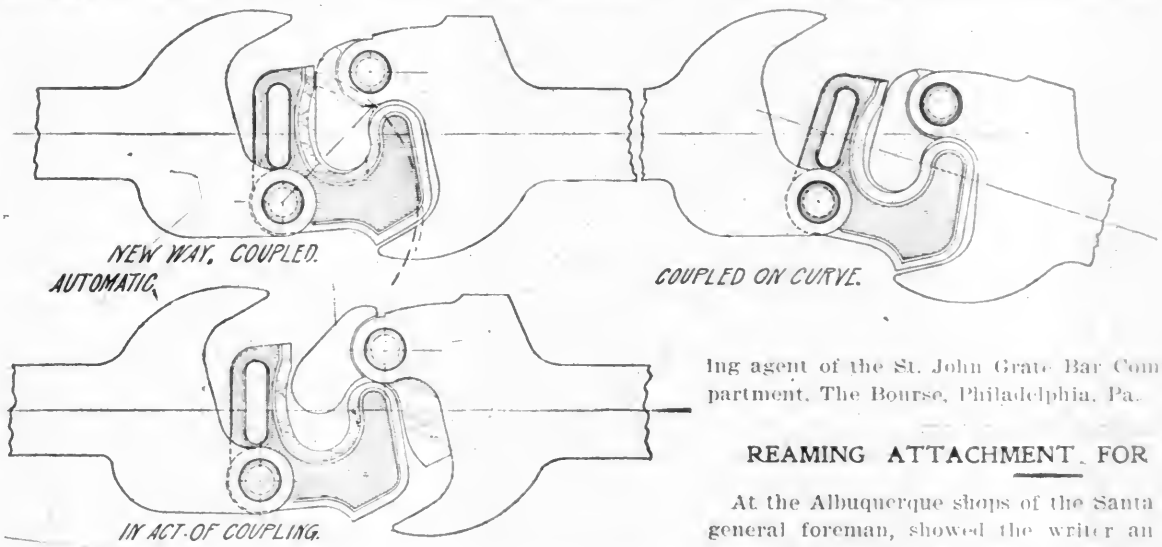

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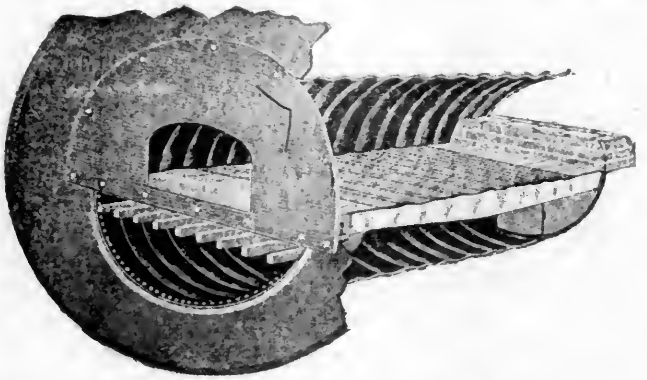


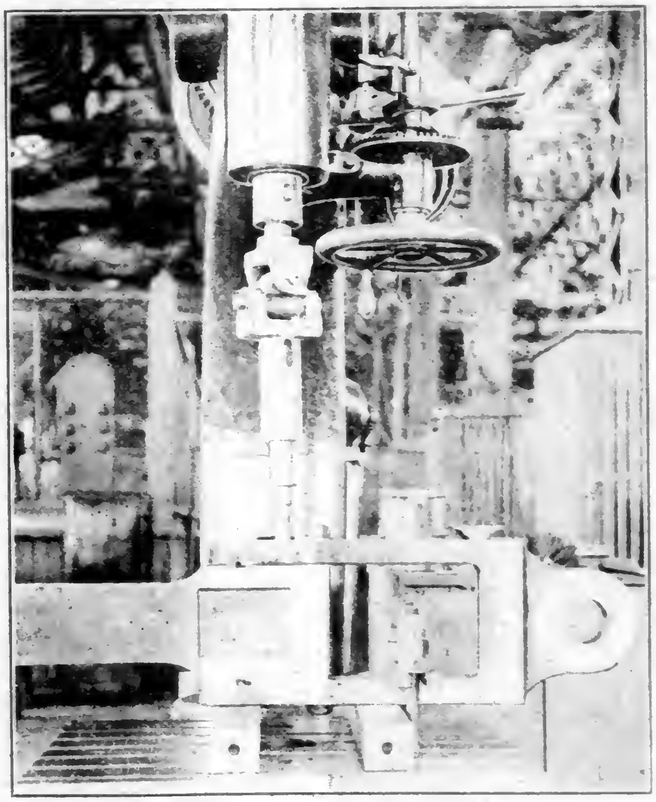
THE ST. JOHN GRATE BAR, AS APPLIED TO A MARINE BOILER.

the bottom of the fire evenly the clinker is carried to the ash pit as soon as possible instead of forcing it upward through the fire. The cutting effect is produced by the side cutting edges as well as the crests of the corrugations, the large surface of the fire not being disturbed as is the case with bars having a large lifting effect. By this construction a large air space is provided, which benefits the fire and increases the life of the bars. As these are trussed, they are strong and not liable to warp. It is stated that by using these grates a lower grade of fuel may be burned and the frequency of cleaning fires largely reduced. Clinker does not fasten itself to these grates and this is in itself a reason for long life, as well as economy of fuel.

The engraving illustrates the application to a marine furnace, where the qualities of grates are more severely tested than in any service, except possibly that of locomotives. This is unquestionably a good grate bar. Further information may be had from Mr. A. B. Willoughby, selling agent of the St. John Grate Bar Company, Machinery Department, The Bourse, Philadelphia, Pa.

REAMING ATTACHMENT FOR ROD STRAPS.

At the Albuquerque shops of the Santa Fe, Mr. W. L. Essex, general foreman, showed the writer an excellent device for reaming holes for rod strap bolts. The expense of reaming these holes by hand led to experiments upon driving the reamer by power in an ordinary drill press. In such work it is essential that the reamer should "float" and be unrestrained



DEVICE FOR REAMING ROD STRAPS.

and free from constraint of the machine as to alignment. This is provided in this attachment by a universal joint, the construction of which is clearly seen in the accompanying engraving. The upper and lower shanks of the jointed part fit the spindle of the machine and the reamer with the usual tapers. Special care in leveling the rod does not seem to be at all necessary, and the results are all that may be desired. The drill press is made ready and the work set up in about ten minutes. It then requires about fifteen to twenty minutes to ream a hole. Doubtless this time will be very much reduced as the men become accustomed to the work.

AN INTERESTING NEW 17-INCH ENGINE LATHE.

WITH POWER-FEED AUTOMATIC TURRET ON THE SHEARS.

GREAVES, KLUSMAN & CO.

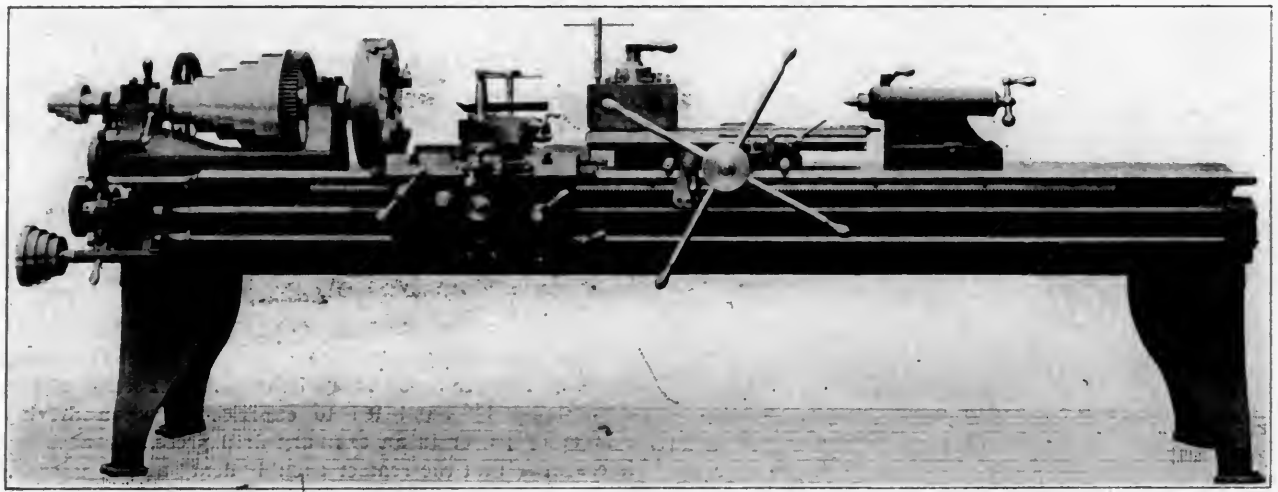
We desire to call attention to a new design of engine lathe which has recently been perfected by Greaves, Klusman & Co., Cincinnati, Ohio, for the reason of the large number of modern labor-saving attachments that have been incorporated and also the application of an automatic power-feed turret on the shears, for rapid duplicate manufacturing, which is becoming so very important in large railroad shop practice. A lathe of the type illustrated herewith is particularly adapted for use in railroad shops, inasmuch as it can so easily be changed over for either plain lathe work or for rapid duplicate manufacturing. This is an important feature, as in many of the smaller shops it might not pay to have a separate turret lathe, while a duplicate machine of this kind could easily be afforded, as it would never need to be idle.

Two illustrations are presented, one a front view and the other a rear view. As may be seen at a glance from its general appearance, this lathe is well proportioned and is apparently well equipped for the heaviest work within its range. The builders inform us that all parts have been newly designed and that an entirely new set of patterns were provided—this to enable the tool to be brought up to the strength required by the new high-speed tool-steel practice.

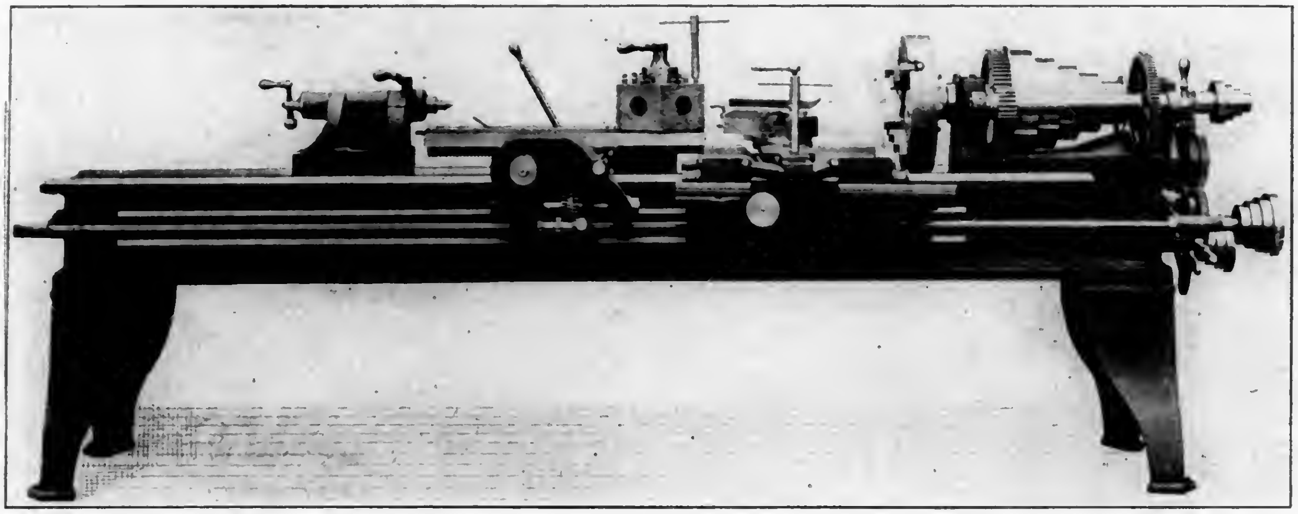
Both the headstock and the tailstock are built very heavy, and the spindle is large and is finished by grinding to ensure absolute truth of round. The carriage has a bearing throughout its entire length on all four of the V-ways to provide ample rigidity. The design of the apron mechanism is most up-to-date and improved, embodying an arrangement whereby all feeds are reversed at that point and also a safety device to prevent both the rod and the screw feeds being thrown in at the same time. An index dial arrangement is provided on the carriage, in connection with the lead screw, to take care of thread cutting, so that there is no necessity of reversing the lathe when running the threading tool back for another cut.

A full range of geared feeds are provided by the change gears, and without the use of the lead screw; there is also a belt feed, having four cone changes, and the feeds may be operated by either belt or gearing, without disconnecting either. Threads may be cut from 2 to 48 per inch, either right or left, without changing any gears. The friction cross-feed is graduated to one-thousandths of an inch and is so arranged that if it is allowed to run beyond its limit no harm will be done—an important feature for the cross feed.

The turret design is heavy and rigid and is calculated to provide for heavy and rapid machining. It is arranged entirely different from prevalent designs, and combines many features of advantage. In addition to the regular feed cone changes, it has in itself three changes of feed, which are directly under the control of the operator, from the front side of the turret by a lever next to the pilot wheel. The builders provide either a round or hexagonal turret for use on this lathe, as desired.



A NEW DESIGN OF ENGINE LATHE, WITH AUTOMATIC POWER-FEED TURRET ATTACHMENT.



REAR VIEW OF THE LATHE, SHOWING TURRET MECHANISM AND TAPER-TURNING ATTACHMENT.
GREAVES, KLUSMAN & CO.

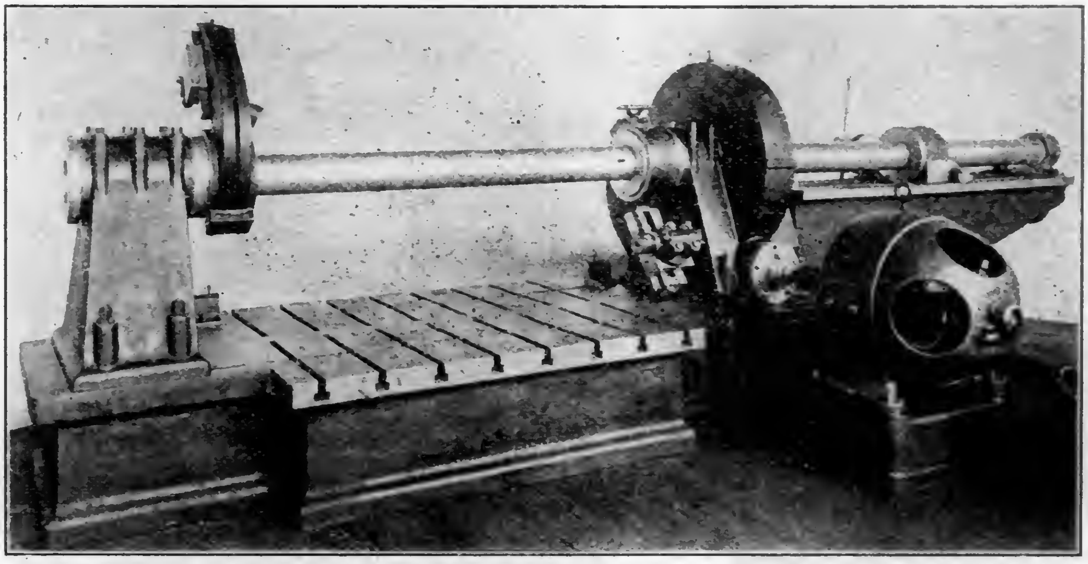
The principal dimensions of this interesting tool are as follows:

Length of bed (6-ft. lathe)	6 ft. 5 ins.
Swing over bed	17¼ ins.
Swing over carriage	9¾ ins.
Will turn in length	2 ft. 10 ins.
Will turn in length, with tailstock extended	3 ft. 2 ins.
Ratio of back gearing	12 to 1
Front spindle bearing	Diameter, 2 13-16 ins.; length, 4¾ ins.
Rear spindle bearing	Diameter, 2¼ ins.. length, 4¼ ins.
Hole in spindle	1 7-16 ins.
Compound rest travel	4 ins.
Head cone pulley:	2¾ ins. face; 4¾, 6½, 8¼, 10 and 11¾ ins. diameter
Weight of lathe, with 6-ft. bed and turret	2,400 lbs.
Weight of bed, per foot	115 lbs.

AN INTERESTING MOTOR-DRIVE FOR A HORIZONTAL BORING MACHINE.

At the time when individual motor driving for machine tools was first coming into use, motor applications were made that, in the light of present practice, would be regarded as crude to say the least. But, later, with the benefit of previous experience, the number of creditable designs of motor driving increased, until now it is exceptional to meet with a new arrangement which does not possess a fair quota of commendable features. But even among the most approved designs of the present day, seldom is so simple and commendable an arrangement encountered as the one employed on the drive of the horizontal boring machine illustrated herewith.

The tool is a No. 3 Barret boring machine, similar in all particulars to the belt-driven style, except that the cone pulley is replaced by a Crocker-Wheeler 13-h.p. multiple-voltage system motor, mounted on a special cast-iron base which is bolted to the bed of the machine proper. The equipment occupies a floor space over all of 18 ft. 1½ ins. long (exclusive of the projection of the boring bar), by 7 ft. 4 ins. wide. The boring bar is 6 ins. in diameter and 16 ft. 8 ins. long. An Albro worm and worm gear with a ratio of 70 to 1 transmits power from the motor, thus affording a very smooth and even motion to the boring bar, particularly desirable in cylinder boring and similar work. The worm and worm gear are encased in one casting, which protects the gears and also, with by means of a stuffing box surrounding the worm shaft, retains the lubricating oil.



A REMARKABLY SIMPLE ARRANGEMENT FOR ELECTRIC DRIVING UPON A BARRET BORING MACHINE.—13-H. P. CROCKER-WHEELER MULTIPLE VOLTAGE MOTOR.

The bearings in the pedestals supporting the boring bar have their centers 24 ins. above the bed and are bored out 9 ins. in diameter to provide for sleeves, which are fixed against endwise displacement but are provided with feathers which engage the keyway extending the length of the splined boring bar so as to cause all to rotate simultaneously. The arms, which carry facing blocks, are mounted on extensions of the sleeves between the pedestals. The latter support the facing tools and are arranged to feed axially or at right angles thereto.

For inside boring a cutting head, not shown, is secured to the boring bar, the feeding being accomplished by sliding the whole bar endwise. The extended frame shown at the right of the machine with a third bearing at its outer extremity contributes to the rigidity of the bar and supports the feeding mechanism, which consists of a slidable carriage containing a sleeve that revolves with the boring bar and may be secured to it at any point, so that any shifting of the carriage causes a lengthwise movement of the boring bar.

The drive to the tool has only one speed reduction, but the machine has a range of twelve speeds in either direction, varying from 2 2-7 to 15 3-7 rev. per min., secured by speed control of the motor. The motor is wound for the Crocker-Wheeler multiple-voltage system, whereby six fundamental speeds are obtained by different voltage combinations, increasing by increments of 40 from zero to 240 volts and the six intermediate speeds through the use of a small resistance between each fundamental step.

The Barret boring machine is built by the Meadville Vise Company, Meadville, Pa., and the motor applied is a size 10-I shunt motor, semi-enclosed type, supplied by the Crocker-Wheeler Company, Ampere, N. J.

For an increase in speed of a single knot per hour, it is necessary to add 30 ft. to the length of a 25-knot ship, and to add 16,000 h. p. in the machinery, also 1,255 additional tons of coal must be provided. This would involve increasing the displacement by 3,100 tons and adding 80 men to the engineer's staff. The increased cost would be $1,250,000. Recent negotiations between the Cunard Company and the British admiralty concerning the building of two new 25-knot vessels developed an estimate of the comparative costs of construction and operation of 20 and 26-knot vessels, the investigation being based on a 20-knot ship 600 ft. long, with 19,000 h. p. and consuming 2,228 tons of coal in a single trip. Such a ship would cost $1,750,000. A 23-knot vessel would be 690 ft. long, would require 30,000 h. p., and would cost $2,875,000. A 25-knot vessel would be 750 ft. long, would require 52,000 h. p. and would cost $5,000,000. A 26-knot steamer would need to be 780 ft long and require 68,000 h. p., the cost being $6,250,000. The engineer's force on a 20-knot steamer numbers 100; a 23-knot 150 men; a 25-knot, 260 men and a 26-knot, 340 men. These interesting figures showing the price which must be paid for high speeds at sea are taken from the *Scientific American.*

A gas engine of 3,000 h.p. is promised as a feature of the approaching World's Fair at St. Louis. It will be exhibited by the John Cockerill Company, Seraing, Belgium, and will be direct-connected to an electric generator.

MASTER STEAM BOILER MAKERS' ASSOCIATION.

This organization will hold its second annual convention in the Palmer House, Chicago, October 7 to 10. A large attendance of superintendents, foremen, assistants and "layer-outs" is expected.

A NEW DESIGN OF MULTIPLE-SPINDLE MUD-RING AND FLUE-SHEET DRILL.

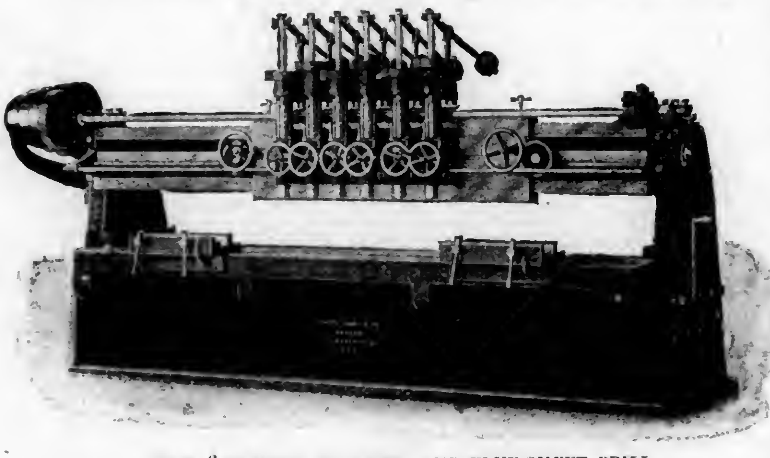
For Locomotive Work.

FOOTE, BURT & COMPANY.

This drill, which is shown in the halftone presented herewith, has been designed especially for mud-ring and flue-sheet drilling on locomotive work, although it is also suitable for any other type of multiple drilling.

The distinctive feature of this tool lies in mounting the six independently-fed heads, which are adjustable in their center distance, on an auxiliary cross rail, this cross rail, in turn, being adjustable the entire length of the main cross rail. By this means a mud ring can be dropped into the two chucks shown on table and securely clamped, and then without moving the work in these chucks, either one or two rows of rivet holes can be drilled the entire length at any spacing desired.

All that is necessary is to set the heads on the auxiliary cross-rail at any given multiple of the desired pitch of the rivet holes. For instance: if the rivet holes are to come at 2-inch centers, the heads are set at 6-inch centers, and six holes drilled simultaneously; then the auxiliary crossrail, carrying the six heads, is moved 2 inches and six more holes are drilled,



NEW 6-SPINDLE MUD-RING AND FLUE-SHEET DRILL. WITH AUXILIARY CROSS RAIL. FOOTE, BURT & CO.

the operation being repeated the entire length of either mud ring or flue sheet. In case there are two rows of holes in the mud ring, after the first row is completed, the table is merely adjusted out or in, as the case might be, to whatever distance is required between the two rows of holes, and then the drilling operation can be repeated. For flue-sheet work, the same mode of operation would be pursued, the chucks having been first removed from the table.

The drill is provided with four spindle speeds and three feeds, and weighs, as shown, about 17,500 pounds. The manufacturers are Foote, Burt & Company, Cleveland, Ohio.

SPECIFICATIONS OF THE FOOTE, BURT & CO. MUD-RING DRILL.

Minimum distance between spindles	6 ins.
Maximum distance between spindles	12 ins.
Distance between housings	12 ft. 4 ins.
Length of auxiliary cross rail	6 ft.
Dimensions of table	12 ft. 4 ins. x 24 ins.
Cross Adjustment of table	24 ins.

The coal-handling machinery installed by the C. W. Hunt Company at the Lincoln Wharf power station of the Boston Elevated Railroad recently made a new record for rapid unloading. The coal was raised 90 ft. above tidewater and delivered to the storage pockets at the rate of 320 tons per hour. The installation follows in general design the standard Hunt steeple-tower rig, the moving gear and coal cracker being electrically driven and the hoisting engine direct-connected. The folding boom has an overhang of 40 ft. and the capacity of the shovel is 2 tons.

PISTON VALVES IN DRIFTING.

The report of the committee on lubrication of piston rods presented to the Traveling Engineers' Association records an interesting experiment to ascertain the effect of allowing a locomotive to drift with the reverse lever "hooked up," and thus test the recommendation made before the Master Mechanics' Association.

"After the engine had worked steam constantly from Scranton to Gouldsboro, a distance of 21 miles and a grade of 60 ft. to the mile, steam pressure maintained at 205 lbs. the entire distance, I applied an alloy that melts at 286 degs. to the piston rod on arrival at Gouldsboro, but it would not melt. After shutting off the steam and drifting down the mountain I left the reverse lever in working notch. The speed ranged from 25 to 32 miles per hour. The distance the engine drifted was 24 miles, when speed was reduced to about 25 miles per hour. Relief valves opened only a very short space of time and only just a very small opening as the engine was passing the centers. When speed was above 25 miles per hour the relief valves did not open at all. When about half way down the mountain I could smell the cylinders heating up. I applied engine oil to the piston rods and a cloud of smoke arose from them. When about three-fourths of the way down the mountain I applied an alloy that melts at 286 degs. temperature to the outside of cylinder directly over the steam passage to the front end of cylinder, but the contact was rather poor on account of the scale on the metal. Nevertheless it melted. On arrival at the foot of the mountain we stopped and I applied the alloy that melts at 310 degs. to the piston rod and it melted in 5 seconds. I applied an alloy that melts at 334 degs. and it came very near melting. It softened up so that the lead pencil with which I held it to the rod made an indentation in the metal. This engine's valves were blowing quite badly at the time this test was made; otherwise I am sure that the temperature would have been raised very much higher. It was also evident to me that if the speed had been increased to 50 or 60 miles per hour the temperature in cylinders would have been so high that lubrication would have been of no benefit.

"On the next trip I experimented on the same lines with the exception of dropping the reverse lever to the corner while drifting, and at no time could the 286-deg. alloy be melted, not even on piston rod at foot of mountain. This practice of leaving the reverse lever in the working notch while drifting may not work any serious results if only practiced while drifting into stations, making stops, but I am satisfied that it will not work on long descending grades, especially at high speed. It certainly will result in cut cylinders and valves, as you can get no benefit from the lubrication on account of the increasing temperature caused by excessive compression. In my opinion the only way to keep the reverse lever in working notch when drifting is by the adoption of some automatic valve arrangement for relieving compression."

Development of the by-product coke ovens would seem to offer the solution of the problem of furnishing gaseous fuel at a low rate of cost, and methods of distribution to comparatively long distances make it possible to locate the producing plants at convenient geographical and commercial points. That there is a great waste of fuel where the gas from the ovens is not utilized is shown by figures given for the beehive ovens between Altoona and Pittsburg. These ovens probably make 20,000 tons of coke per day, from which about 100,000,000 cubic feet of gas discharge into the air. This gas, if converted into power through gas engines, would represent 5,000,000 h.p. hours, or the effort of about 104 gas engines of 2,000 h.p. each. Manufacturers of gas apparatus are now offering to guarantee the production of a horsepower hour for 1 lb. of fuel—a result not at present attainable through the medium of steam engines and boilers, except by the most complex type of engine.—*H. G. Morris, before Engineers' Club of Philadelphia.*

BOOKS AND PAMPHLETS.

The Drafting of Cams. By Louis Rouillon, Instructor in Mechanical Drawing at Columbia University. 23 pages, 6 x 9 ins., in pamphlet form. The second of a series of practical papers, published by the Derry-Collard Company, 256 Broadway, New York. Price 25 cents.

The important subject of cam design is elucidated in a most commendable manner in this pamphlet by a clear explanation of the principles involved and the citation of methods of treatment for a number of practical examples. The two methods of laying out a heart-shaped cam are used to illustrate the general method. This is followed by a treatise of the more difficult cam problems—those whose lines of action are not central with the cam axis. The treatise ends with the problem of the design of a cam belt-shifter to automatically shift the belts of an iron planer at reversals of motion of the platen. The latter is one of the problems in machine design regularly given to the students in Mechanical Engineering at Cornell University, and involves very interesting study. This work deserves to be especially recommended owing to the wide experience of the author, not only in the line of practical work, but also in the problem of instruction in drawing. The typographical work and paper used in the pamphlet are of the highest order, making a beautiful result. This pamphlet is to be followed by others of equal interest on important engineering subjects. Further information upon the subject may be obtained from the Derry-Collard Company.

The Art of Pattern-Making. A comprehensive treatise, with numerous examples of all kinds of pattern work. By I. McKim Chase, M.E. 260 pages, 12mo, cloth, and 215 figures. 1903. Published by John Wiley & Sons, 43 East Nineteenth street, New York. Price $2.50.

This is a work the advent of which will be welcomed by those interested in the important subject of pattern-making. As stated in the preface, "the literature pertaining to pattern-making is by no means as extensive as the importance of the business warrants," and the lack has long been felt. The author has, in presenting this work, endeavored to record the results of his long and extensive experience, the majority of the practical examples given being taken from his personal experience. These are, however, supplemented by further practical examples drawn from the experience of others, and from those that have appeared in the technical press. The work begins with a considerable space devoted to the equipment and management of a pattern shop, after which is presented the very comprehensive series of examples of practical pattern work for all classes of molding, from pipe elbows to complicated cylinder castings and screw propellers, cast whole or with separable blades. Considerable attention is paid to the important subject of core-box work, several excellent examples being given. The interest that the author has taken in his life work is evidenced in a remarkable manner in this book and we believe it will be found a desirable acquisition to pattern-making literature.

Universal Directory of Railway Officials, 1903. Compiled from Official Sources under the direction of S. Richardson Blundstone, editor of the *Railway Engineer*. Published by the Directory Publishing Company, 3 Ludgate Circus, London, E. C. Representative for the United States, E. A. Simmons, 1333 Broadway, Brooklyn, N. Y.

This is the ninth annual edition of this valuable directory of the principal railway officials of the world. It has been enlarged as well as revised and now includes practically all the railways and tramways operated by power in the United Kingdom. In addition to the names of officials the book includes information concerning the length and equipment of every railroad. It is invaluable to those who have correspondence or dealings of any kind with railway officials.

British Standard Sections. Issued in pamphlet form by the Engineering Standard Committee (England). D. Van Nostrand Company, 23 Murray street, New York. Price $1.

This publication consists of nine lithograph sheets in pamphlet form and contains the dimensions, thickness and profiles of the standard structural sections, that are recommended by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers. The moments of inertia and other important properties of these sections are to be issued at a later date. American engineers will note particularly the large size angles and Z-bars contained in the list, the largest angle being 10 ins. x 4 ins., and the largest Z-bar, 10 ins. x 3½ ins. x 3½ ins. American builders may find this pamphlet a useful guide whenever the condition of the market makes it desirable to purchase English steel.

Railway Carriages and Wagons, Their Design and Construction. By Sidney Stone, Assistant Works Manager, Great Central Railway, England. Part I. Illustrated, 176 pages, 9 x 12 ins. in size. Published by the *Railway Engineer*, 3 Ludgate Circus Building, E. C., London, England. Price, 10s. 6d.

This is the fourth work by these publishers in the Railway Series of Text-Books and Manuals by Railway Men for Railway Men and Others. It is a series of articles contributed by the author to the pages of the *Railway Engineer*, rewritten for the purpose of filling the need for a standard book on this subject. It represents English practice in car construction and includes a large number of excellent photographs and reproductions of working drawings. The author begins with a study of woods. Wood working machinery is next considered and underframes taken up. Buffers, draw gear and iron details; wheels, axles and journal boxes; trucks and flexible wheel bases and continuous brakes follow in order. It is an excellent record of present English practice, with frequent references to methods used in the United States. While most valuable to foreign engineers and railroad men, it permits of making a careful study of light and strong construction in cars which might be made with advantage by those who are concerned in the very heavy construction used in this country.

The Star Improved Steam Engine Indicator. By Geo. H. Barrus, Expert and Consulting Steam Engineer. 140 pages, 12mo. cloth, fully illustrated. 1903. Published by the Star Brass Manufacturing Company, 108-114 East Dedham street, Boston, Mass. Price $1.00.

This is a treatise upon the principles and management of the steam engine indicator, which was prepared for the Star Brass Company, manufacturers of the well-known Star indicator. It is, in one sense, an advertisement of this particular make of indicator, but nevertheless the treatment of the subject takes the form of an unbiased statement of the important principles and the book contains much that is useful in indicator practice. A large portion of the work is devoted to a complete description of this particular instrument, while the latter part tells how to indicate an engine and make the necessary calculations. A large number of sample cards are shown, nearly all of which were taken personally by the author with the new Star indicator for this treatise. This book may be had either from the D. Van Nostrand Company, 23 Murray street, New York, or from the author at 12 Pemberton Square, Boston, Mass.

INDEX OF THE TECHNICAL PRESS.—The fourth number of this pamphlet has been received and is four times the size of the first number, indicating marked progress in value. The references are in French, German and English and include the principal articles of general interest appearing in the technical journals throughout the world. The work is well done and the classification excellent. It is published by the Association de la Press Technique, 20 Rue de la Chancellerie, Brussels, Belgium.

SPECIFICATIONS FOR PORTLAND AND NATIONAL CEMENT AND PORTLAND CEMENT CONCRETE.—The American Railway Engineering and Maintenance of Way Association has prepared the specifications, adopted this year, in pamphlet form. The pamphlet also contains specifications for concrete, submitted by the committee on masonry, but not yet adopted. Copies may be obtained from the secretary, Mr. E. H. Fritch, room 1562, Monadnock Block, Chicago. Price 10 cents.

SMALL TOOLS, STANDARDS AND GAUGES.—This is the title of a very complete catalogue of the small tools for machine shop use and also special tools which are manufactured by the Small Tool Department of the Pratt & Whitney Company, Hartford, Conn. It is of a handbook size, contains 182 pages, and is profusely illustrated by excellent engravings. A large portion of the book is taken up by descriptions of the very complete assortment of taps and dies which this company is noted for. Besides the usual hand taps of all standards a specialty is made of washout-hole-plug taps, staybolt taps and spindle retapping staybolt taps for locomotive boiler use. Also a large assortment of special patent dies and also die stock sets are illustrated. The stock of milling cutters, both solid and with inserted blades, angle cutters, slotting cutters, end and hollow mills, and also reamers of all styles and for all purposes may be seen to be very large. The remaining portion of the book illustrates a number of special tools which the Pratt & Whitney Company make a specialty of, including the Renshaw ratchet drill, the P. & W. special threading tool, special boring, knurling and other tools for lathe use, standard punches and dies for boiler plate work, etc., etc., and also a complete line of standard measuring machines, standard size and thread gauges, and gauges for special purposes, as for M. C. B. standard automatic couplers, new and worn knuckles, and flange thickness and wheel defect gauges.

THE NATIONAL MACHINE TOOL COMPANY.—A new catalogue has been issued by this firm to describe their improved portable keyseating tools, which they have lately placed on the market for use in connection with the drill press. This interesting and remarkable device is meeting with unusual success and approval in all quarters, for its simplicity as well as its efficiency. It is adapted to the cutting of internal keyseats of all sizes, both straight and taper, and in all metals. It is interesting to note that this very useful tool was developed by Mr. Schellenbach, of the National Machine Tool Company, as a special tool for use in the manufacture of their mechanical speed variators, a complete description of which was presented on page 229 of our June, 1903, issue. For cutting the keyseats in the large number of gears used in that device this tool has proven unusually effective and efficient.

PRECISION LATHES.—The Pratt & Whitney Company, Hartford, Conn., have just issued one of their standard 6 x 9 catalogues, which is devoted to their bench lathe, 10-in. toolmakers' lathe, 13-in. engine lathe and 14-in. gibbed-carriage engine lathe. The book contains 67 pages and is beautifully illustrated with excellent halftones. The first thirty-seven pages are taken up with a description of the 7 x 32-in. bench lathe, which is described in detail, and illustrations are presented of more than thirty of the various attachments which may be furnished with the lathe, giving an adequate idea of the great diversity of work for which this machine is adapted. The 10-in. toolmakers' lathe is also carefully described, and illustrations are given showing the application of collets and split step chucks to the spindle. There are two views of the 14-in. lathe, one showing the standard lathe and the other the lathe with the pan bed. A number of important attachments for this lathe are illustrated and described, including a relieving attachment for relieving straight, taper and spiral taps and milling cutters, drawback collets, step chucks and closers, and expanding arbors. These lathes perhaps are not applicable to the ordinary run of shop practice, but to anyone who cares for good machines, or who has to do accurate work, they will certainly be highly appreciated.

The Bureau of Forestry, United States Department of Agriculture, has inaugurated an investigation of the mechanical properties of the commercial timbers of the United States, and has established a timber-testing station at Purdue University, Lafayette, Ind., to form the nucleus of the work in the Mississippi Valley region. Other stations have been established at the University of California, at the Yale Forest School, and at Washington, D. C. Various physical and mechanical tests will be made according to uniform methods at these stations by experts of the Bureau of Forestry. This action of the bureau in establishing a testing station at Purdue University does not involve the erection of additional buildings, but a more thorough utilization of equipment already existing in the laboratory for testing materials. Additional machines of a special character, however, belonging to the bureau, will be installed in the laboratory for the needs of this work. The work of this station will be under the direction of Dr. W. K. Hatt, who has recently been appointed to have supervisory charge of the work of all the timber-testing stations of the Bureau of Forestry. Responsibilities thus assumed by Dr. Hatt will not interfere with the discharge of his duties at Purdue University.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. Walter D. Crosman, who is well known from his long connection with railway newspaper work and association with railway supply business, has opened an office in suite 710, 125 La Salle street, Chicago. He will serve the railway and allied trades with the Wachter Manufacturing Company's Army and Navy liquid glue, the Wilbern adjustable door-hanger, and the Wadsworth-How-
We join Mr. Crosman's many land Company's carburet black. friends in wishing him the success which his wide acquaintance and knowledge of railroad requirements are sure to bring him.

Judge Archibald, of the United States Circuit Court, Eastern District, Pennsylvania, has recently handed down a decision in the suit of the Westinghouse Electric and Manufacturing Company against H. C. Roberts and the Sangamo Electric Company which has an important bearing upon alternating current meters and fan motors, in that the claims of the so-called Tesla Split-Phase patents were sustained. The defendants' device against which suit was brought was the Sangamo meter. The court, after a careful review of the testimony, decided that the complainants had satisfactorily proved that Tesla's date of invention preceded that of Farraris and others, and that the device in question was an infringement.

The Washburn Coupler Company, of Minneapolis, Minn., announces that its stock, property and business have been acquired by the Washburn Company, of that city. The change of ownership is made in order to extend the business in car couplers and other lines of railroad supplies and does not involve any great changes in the management.

An interesting shipment of large steam turbine machinery has recently been made from the shops of the Westinghouse Machine Company, Pittsburgh, Pa., which will be the first large steam turbines of American manufacture to be exported. The shipment consisted of two 1,000-kw. Westinghouse turbine generating units of the most recent design, which are intended for light and power service in the De Beers mines, at Kimberly, South Africa.

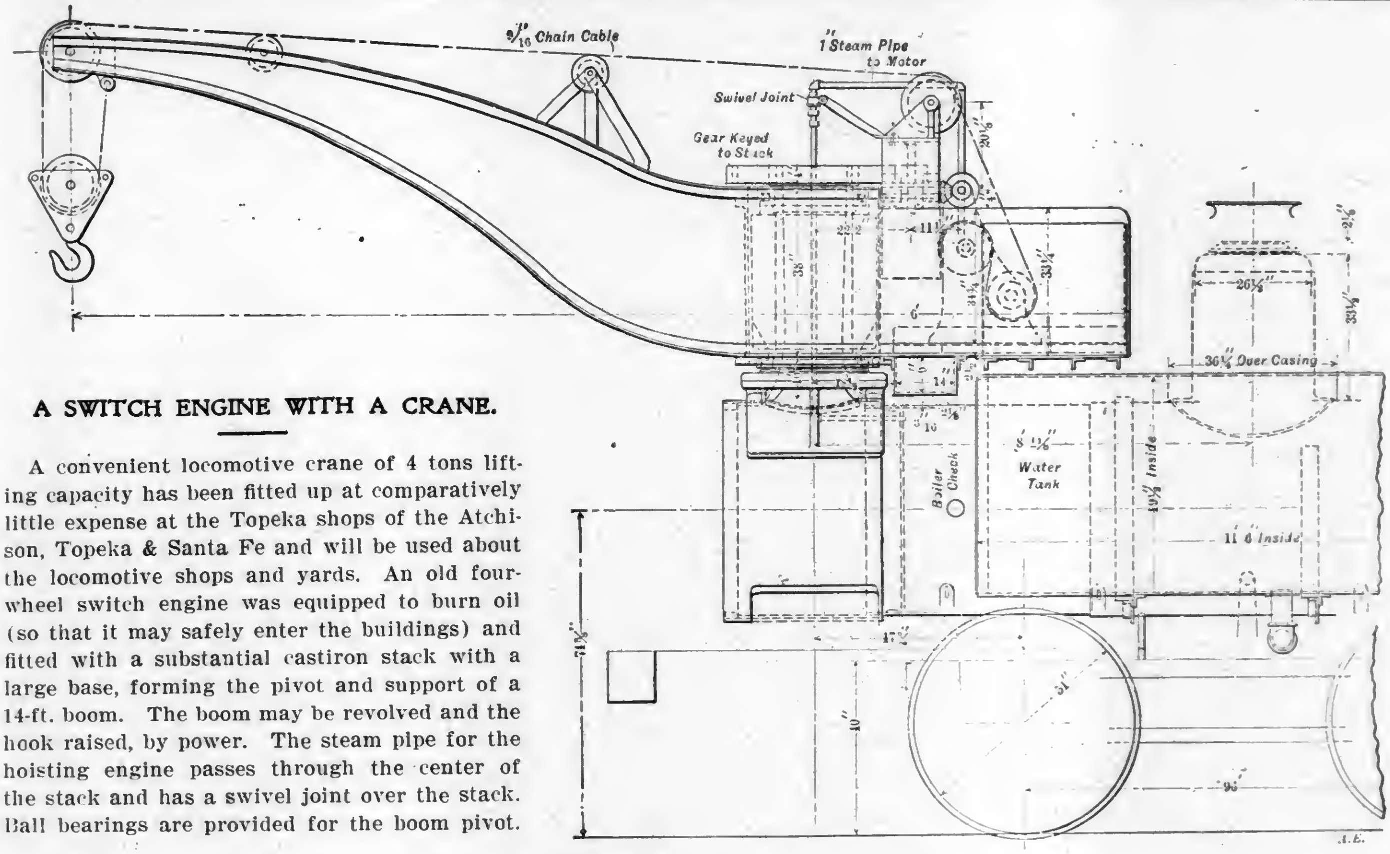
The New York offices of the sales organization of the Westinghouse Electric and Manufacturing Company have been removed to the new Hanover Bank Building, corner of Nassau and Pine streets. The new offices occupy the entire seventeenth floor of this building, one of the finest and best equipped office buildings in the country, where the arrangements and facilities will be of the best, both for the representatives of the company and the public with whom they do business. The mail address will be No. 11 Pine street. The executive, financial and stock transfer offices of the company will remain on the fourth floor of the Equitable Building, in which the present organization of the company has been quartered since 1889. The rapid and material increase of business has made the above move necessary.

The Chicago Pneumatic Tool Company requests the publication of the following statement:

"During the past few days a vast amount of gossip has been printed relative to this company, the majority of which was entirely without foundation and apparently malicious in nature. As it does a great injustice to the company and its officials, we would request that you print the following statement which is in every respect a true and correct statement of the affairs of the company:

"In the first place President Duntley is not going to resign. It is due to his knowledge, energy and ability that the pneumatic tool business has grown to its present vast proportions. This is fully recognized by the directors and none of them desire his resignation. The report that he does not have the confidence of Mr. Schwab or Mr. Matthiessen is entirely without foundation and there is no justification in the report that he anticipates retiring or that any stockholders desire him to do so. The fact that Mr. Schwab has purchased from Mr. Pam the stock owned by the latter is true and this transaction was a private one between them. It originated with them and none of the other officers or stockholders have anything to do with it. Therefore, Mr. Pam having sold all of his stock, it naturally followed that he should resign from the directory, which he has done entirely of his own accord. The executive offices of the company are to be moved to New York and it is due to this fact that some of the directors have tendered their resignations. Mr. Schwab is the largest stockholder in the company and has expressed a desire to take an active part in the direction of the company's business, as has also Mr. Matthiessen. Their action is entirely justified by their present holdings in the company, and as they both live in New York, it is necessary that the executive offices be located in that city.

"As regards Messrs. Wacker, Chalmers and Lynch, these gentlemen agreed when they accepted places on the board that they would do so only if the executive offices were located in Chicago, as it would be impossible for them to attend meetings in New York City, as they could not take the time from their other affairs. Naturally, therefore, when they learned of the proposed change in location, they were opposed to it, as they felt it impracticable for them to continue on the board and executive committee, and they accordingly tendered their resignations. In all probability the number of directors will be reduced from fifteen to nine, as the members are widely separated and it is difficult to obtain a quorum with the present number. The affairs of the company are in a most flourishing condition and the prospects are exceedingly bright for them to continue so in the future. The various plants are working increased forces in order to adequately fulfill the requirements. Their foreign offices report a correspondingly cheerful outlook. The business for the month of August just past exceeded that transacted in August, 1902, and there is every indication that the present month of September will be very satisfactory as regards sales of pneumatic appliances."



A SWITCH ENGINE WITH A CRANE.

A convenient locomotive crane of 4 tons lifting capacity has been fitted up at comparatively little expense at the Topeka shops of the Atchison, Topeka & Santa Fe and will be used about the locomotive shops and yards. An old four-wheel switch engine was equipped to burn oil (so that it may safely enter the buildings) and fitted with a substantial castiron stack with a large base, forming the pivot and support of a 14-ft. boom. The boom may be revolved and the hook raised, by power. The steam pipe for the hoisting engine passes through the center of the stack and has a swivel joint over the stack. Ball bearings are provided for the boom pivot.

DETAILS OF THE CRANE, INDICATING ARRANGEMENT OF HOISTING AND TURNING MECHANISM.

GENERAL VIEW OF ENGINE.

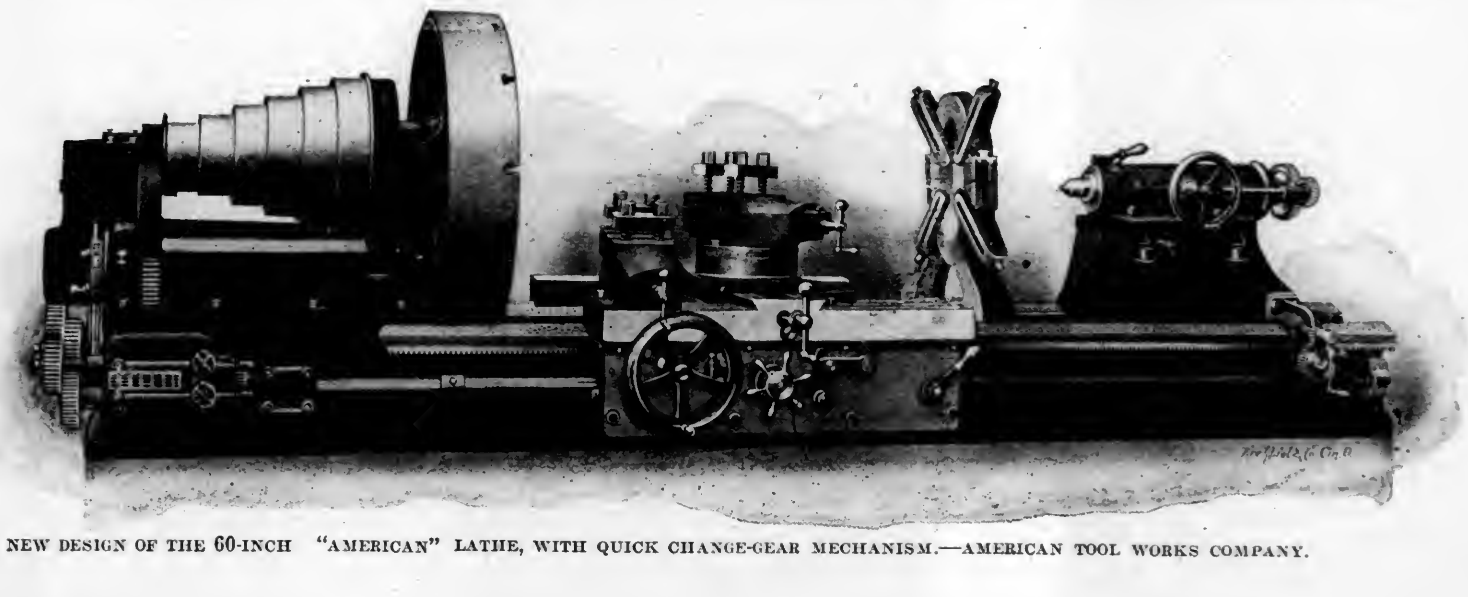
Tanks for 250 gals. of oil and 1,600 gals. of water are carried on the engine. In working order with full tanks of water and oil the engine weighs 106,750 lbs. The drawing was furnished by Mr. G. R. Henderson, formerly superintendent of motive power of the road. In a large shop plant such a crane finds a wide field of usefulness and saves a large amount of manual labor.

NEW 60-INCH LATHE, WITH CHANGE-GEAR MECHANISM, AND A NEW DESIGN OF PLANER.

THE AMERICAN TOOL WORKS COMPANY.

The accompanying engraving is an illustration of the new heavy model of the "American" lathe which has been brought out by the American Tool Works Company, Cincinnati, Ohio. This tool is their 60-in. lathe with improved rapid-change-gear mechanism, which greatly increases its possibilities as a rapid handler of heavy work.

The change-gear mechanism, which is located on the head end of the bed, consists of a clutch device of an entirely new design, through which seven changes for feeding and screw cutting are readily available without the removal of a single



NEW DESIGN OF THE 60-INCH "AMERICAN" LATHE, WITH QUICK CHANGE-GEAR MECHANISM.—AMERICAN TOOL WORKS COMPANY.

gear. Then, by changing one, and only one, gear on the stud, seven additional changes are provided, the quadrant being so designed as to obviate the readjusting of the entire train of gears to each new change gear. Nine change gears are ordinarily furnished, thus providing a total of 63 changes of threads and feeds with the minimum of effort.

Each of these possible changes is indicated on the index plate located on the front of the gear box; by the simple movement of a hand wheel a pointer is brought directly above the desired thread or feed. This will indicate the number of the change gear to be placed on the stud, and also automatically arranges the gears in the gear box for cutting the thread or feed desired. The range of threads is from 1 in 8 ins. to 16 per in., and of feeds, from 1.327 to 170.

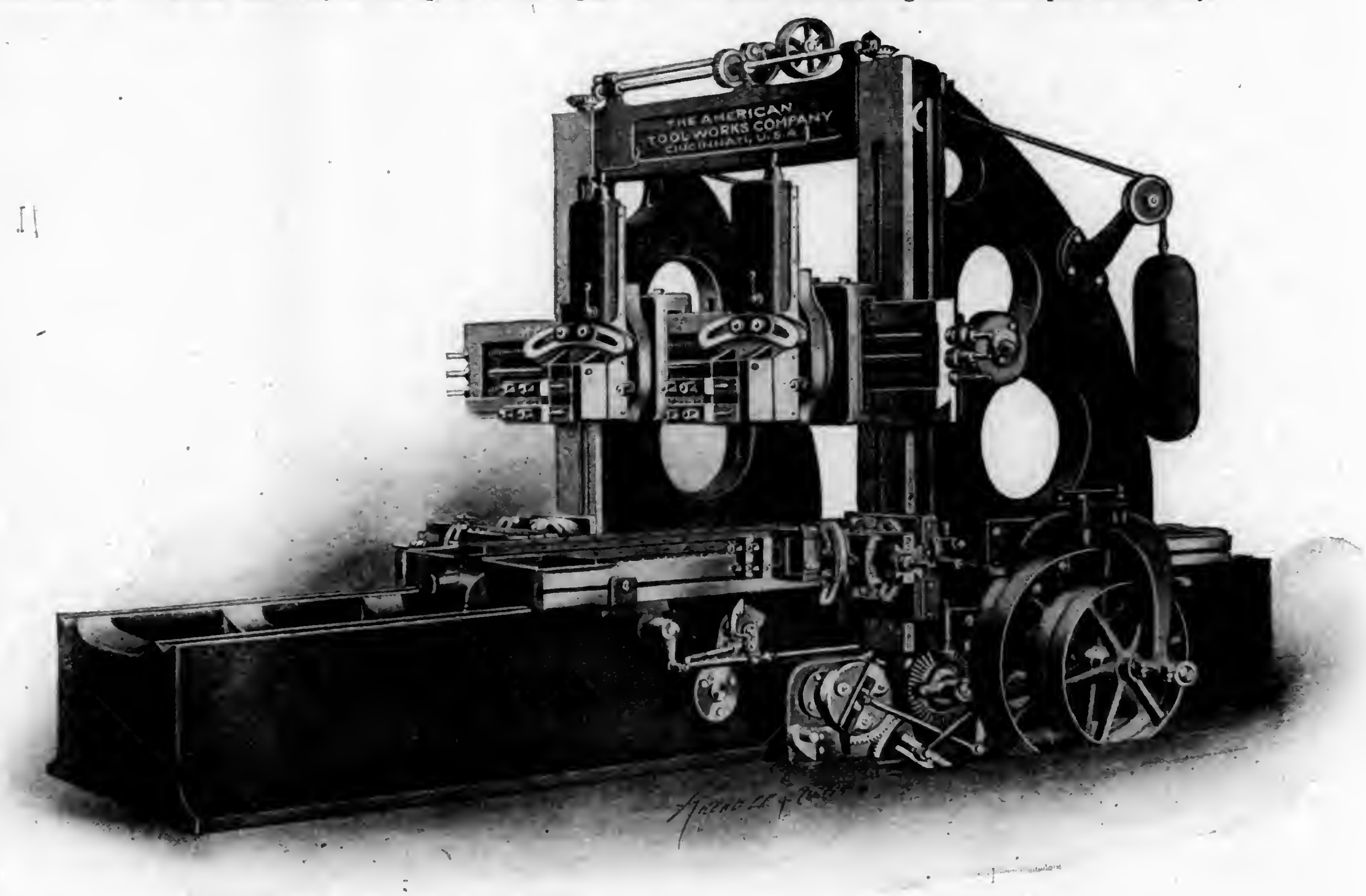
The lathe can be changed for left-hand screw cutting by means of tumbler reverse plate, mounted on the end of the headstock. It is not necessary to interpose an idler gear as formerly, and no gears are disarranged by this improved method.

The bed is of patent drop-V pattern of such construction as to secure the greatest rigidity. The headstock is massive and the driving cone is mounted on its own spindle, entirely independent of the main spindle and is powerfully geared. Carriage is very heavy, especially in the bridge, due to the drop-V bed, and has double apron extending full length. All gears are cut from the solid.

THE NEW 48-INCH PLANER.

The illustration presented on this page shows the new design for the 42 and 48-inch sizes of the "American" planers, which has just been brought out by the American Tool Works Company. This concern have lately redesigned their entire line of planers, from 22 inches to 48 inches throughout, with the purpose of adapting them to the greatly increased duties imposed by the new tool steels and modern shop practice. Every condition influencing modern planer work has been given careful consideration, and as a result, the increased efficiency of their planer, and its adaptability for use with high-speed steels, have placed it at the front as a rapid work producer, by the most progressive methods.

Strength and rigidity have been the foremost aims in the new designs. The bed has been made unusually heavy, extra wide between the V's, and thoroughly braced by heavy box girts at short intervals. The bed is of unusual length in proportion to the table, leaving but little overhang to the table when planing at full length. The table has ample thickness, is provided with improved shifting mechanism, which removes the belt from one pulley before the return movement belt engages the other, thus obviating all disagreeable shrieking of belts. A quick return is provided and reverses are made without shock or jar. The table can be run from under the tool for examination of work, and a safety locking device prevents the table from starting before the operator is ready.



THE NEW DESIGN OF THE 48-INCH AMERICAN PLANER.
THE AMERICAN TOOL WORKS COMPANY.

The housings are of the double-webbed cored-section type, with wide bearings for the cross rail, and are fitted perfectly parallel with each other and square with the table. The heads on the rail are made right and left to permit of planing close together, and the saddles are graduated for angular planing. The feeds are automatic in all directions and can be operated from either side of the machine; the down-feed is of exceptional length and is equipped with a micrometer adjustment. The side heads are of compound-slide type, giving the tool exceptional range of travel, and are counterbalanced and can be run below the level of the table when not in use. All pinions are of steel and all shafts are crucible steel of large diameter, each arranged so as to be readily removed when necessary without disturbing the rest of the machine.

Further detailed information regarding these interesting tools will be cheerfully furnished by the American Tool Works Company.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

NOVEMBER, 1903.

RAILWAY SHOPS.

BY R. H. SOULE.

VII.

THE FREIGHT CAR REPAIR SHOP AND YARD.

There exists a growing conviction that the freight car department of a railway shop should include a building in which repair work may be carried on in bad or extreme weather; hitherto on many roads this work has been prosecuted entirely in the open air. It is not probable that a shop will ever be built large enough to take care of all work of that character at a given point, and a considerable amount will always be done out in the open as now; but it is believed that it does pay to be able to concentrate repair forces under cover when large, will usually commend itself. A transverse shop of very large capacity means that the adjacent yard (constituting the track approaches to the shop) must be very wide, whereas a longitudinal shop may be of any moderate width, and as long as necessary to give the required capacity. Another objection to the transverse shop is the increased number of door openings for a given standing capacity and the greater difficulty of heating on that account. The internal transportation of materials can be more readily accomplished in the longitudinal shop by hand trucks on auxiliary tracks, whereas in a transverse shop such auxiliary tracks, if provided at all, must cross all the stall tracks; while other materials may with difficulty be distributed throughout a transverse shop, the handling of mounted wheels can be easily accomplished only in the longitudinal shop on tracks specially provided for the purpose. The largest group in the table is that of the longitudinal shops with track approaches at one end only, and these are also shops and yards of large standing capacity. Under this plan the stock of repair materials may be kept at the stub end of the shop and yard tracks, where they will be most easily reached for distribution, and can be moved down the spaces between the repair tracks by a system of intermediate distribution tracks, preferably narrow gauge. In a large yard this provision might naturally be supplemented by material supplies at lateral or central points. If the intermediate distribution tracks are alternately standard and narrow gauge they may be

TABLE 13—BUILDINGS FOR FREIGHT-CAR REPAIRS.

Place.	Railroad.	Type.	Method of Access.
Oelwein, Iowa	C. G. W.	Transverse.	Transfer table only.
Burlington, Iowa ..	C., B. & Q.	Transverse.	Transfer table and tracks at opposite sides.
Chicago, Ill. (old) ..	C. & N. W.	Transverse.	Transfer table and tracks at opposite sides.
Fond du Lac, Wis..	W. C.	Transverse.	Transfer table and tracks at opposite sides.
Collinwood, Ohio ...	L. S. & M. S.	Transverse.	Transfer table and tracks at opposite sides.
Concord, N. H......	B. & M.	Transverse.	Transfer table and tracks at opposite sides.
Pocatello, Idaho ...	O. S. L.	Transverse.	Transfer table and tracks at opposite sides.
Omaha, Neb.	U. P.	Transverse.	Tracks at both sides.
Sayre, Pa.	L. V.	Transverse.	Tracks at one side only.
Albany, N. Y.......	N. Y. C.	Transverse.	Tracks at one side only.
Chicago, Ill. (new).	C. & N. W.	Longitudinal.	Tracks at one end only.
McKees' Rocks, Pa.	P. & L. E.	Longitudinal.	Tracks at one end only.
Baring Cross, Ark..	M. P.	Longitudinal.	Tracks at one end only.
Montreal, Can.	C. P.	Longitudinal.	Tracks at one end only.
Milwaukee, Wis. ...	C., M. & St. P.	Longitudinal.	Tracks at one end only.
Memphis, Tenn. ...	I. C.	Longitudinal.	Tracks at one end only.
Topeka, Kan.	A., T. & S. F.	Longitudinal.	Tracks at one end only.
Scranton, Pa.	D., L. & W.	Longitudinal.	Tracks at one end only.
Elizabethport, N. J.	C. R. R. of N. J.	Longitudinal.	Tracks at both ends.
Burnside, Ill	I. C.	Longitudinal.	Tracks at both ends.
Oak Grove, Pa.....	N. Y. C.	Longitudinal.	Tracks at both ends.
Readville, Mass. ...	N. Y., N. H. & H.	Longitudinal.	Tracks at both ends.
Brainerd, Minn. ...	N. P.	Longitudinal.	Longitudinal tracks and transfer table at opposite ends.
Roanoke, Va.	N. & W.	Roundhouse.	Turntable.
Columbus, Ohio	Penna. Lines.	Roundhouse.	Turntable.
Altoona, Pa.	P. R. R.	Roundhouse.	Turntable.

circumstances justify it. To make such an arrangement a success it is necessary that the stock of repair materials should be equally accessible from both the shop and the yard, and that cars should be switched in and out more frequently when work is being done exclusively under cover (as in bad weather) than when being done in both shop and yard. Under these circumstances increased annual output may easily compensate for the increased fixed charges which would represent the cost of the required additional buildings.

When the most suitable type of building for freight car repairs is considered, it is found that existing practice is not uniform and leaves the question in doubt. Even in those places where the type of building is the same the method of access to it varies. Table 13 gives the facts for several well-known shop points.

Examining the table, it is noticed that Oelwein is the single case where the access to the shop (in this case transverse) is by transfer table only, and it is extremely doubtful whether such an arrangement can be made to yield good results. It is evidently based on the assumption that freight cars under repairs should be handled individually, as are locomotives and passenger equipment cars; whereas all other arrangements (except the roundhouse) permit of handling and switching cars in strings, which is evidently conducive to economy of operation and increase of output. There is little choice, as regards internal working, between the transverse and the longitudinal shop, if the two have the same standing capacity; but when the layout is considered, the longitudinal shop, if used for mounted wheels and for miscellaneous supplies respectively, and such an arrangement will contribute to the quick and orderly distribution of all materials.

The longitudinal shop with track approaches at both ends is found in a few cases, but it makes the distribution of repair materials more difficult and presents no compensating advantage except the doubtful one of being able to switch the shop and yard from both ends.

The roundhouse form of shop is excellently adapted to the work of building freight cars, especially if used in connection with a 100-ft. turntable, by which means a bob-tail shifter can handle two freight cars in and out of a stall. A visit to Altoona, Columbus or Roanoke while new freight equipment cars are being built is very convincing in this respect, but the turntable is open to the same objection as the transfer table when repair work (as distinct from construction work) is undertaken on a large scale, and at all three of these points more cars are repaired outside of these roundhouse shops than in them.

The only recorded investigation and report on the best arrangement of tracks in a freight car repair yard is that made in 1902 by a committee of the American Railway Engineering and Maintenance of Way Association; that committee recommended that the tracks should be connected at one end only, should be spaced alternately on 24-ft. and 16-ft. centers, with narrow gauge supply tracks running down each 24-ft. space, materials to be brought in from the stub ends, air pipes for testing air brakes to be provided, etc. It was also stated that

such a yard should not be too long, and the one shown by the diagram which accompanied the report is about 1,100 ft. long, and would hold 166 cars, allowing 50 ft. of track per car (as also recommended in the report). By referring to Table 14 it will be seen that a freight car repair yard to hold 166 cars is a small affair, according to present day standards; it is therefore evident that a single yard (including shop) of large capacity must be much more than 1,100 ft. long; the alternative of dividing the work up into several smaller yards is always open, however.

A novel arrangement of tracks in a freight car repair yard is found at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railway; here a long lead track, which is parallel to the general line of tracks in the yard, has a series of spur tracks leaving the lead at an angle of perhaps 30 degs., and each capable of holding about eight freight cars with proper working spaces between; this arrangement permits of treating cars in blocks of eight, and is probably laid out to avoid having longer strings of cars under treatment on one track at one time; it appears to combine some of the features of the transverse system with those of the longitudinal system, and in that respect reminds one of the new Rock Island erecting shop at Moline, Ill., where the same underlying idea is taken advantage of in handling locomotives when under repairs; the West Milwaukee freight car repair yard has been put in use only recently and output results are not yet definitely known, but the arrangement promises well and will be watched with interest.

A tabulated listing of some 25 freight car repair yards shows every variety of practice from placing tracks at 15-ft. centers without any intermediate supply track up to 24-ft. centers with an intermediate standard gauge supply track, and the up-to-date freight car repair yard on a really large scale is something for the future to bring forth. It is doubtful whether the yard recommended by the committee of the American Engineering and Maintenance of Way Association would meet requirements on a large scale, with its 24-ft. and 16-ft. alternate track spacing, and with narrow gauge service tracks down the 24-ft. space only. It seems probable that a yard with tracks uniformly 22-ft. centers, with a light rail standard gauge wheel track down one bay and a single or double line of narrow gauge material track down the next bay, and so on alternately, would come nearer to meeting large scale requirements; such a yard would cover 10 per cent. more ground, but net results would probably be in its favor.

TABLE 14—OUTPUT OF FREIGHT-CAR REPAIR PLANTS.
(Shops and yards considered collectively.)

Place.	Railroad.	Average Total No. of Cars Under Repairs.	Output per Month. Total.	Output per Month. Per Stall.
Allston, Mass...	B. & A.	338	744	2.20
Morris Park, N.Y.	L. I.	34	165	4.85
McKees' R'ks, Pa.	P. & L. E.	728	6,900	9.48
Milwaukee, Wis..	C., M. & St. P.	386	4,377	11.34
Aurora, Ill.	C., B. & Q.	84	520	6.19
Roanoke, Va. ...	N. & W.	95	1,400	14.74
Sedalia, Mo. ...	M., K. & T.	45	222	4.93
Decatur, Ill. ...	Wabash.	75	1,141	15.21
Reading, Pa. ...	P. & R.	247	779	3.15
Elizabethp't. N. J.	C. R. R. of N. J.	72	779	10.82
Detroit, Mich. ...	M. C.	60	244	4.07
Bloomington, Ill.	C. & A.	40	277	6.92
Oneonta, N. Y...	D. & H.	50	1,890	37.80
Chicago, Ill. ...	C., R. I. & P.	60	1,300	21.67
Montreal, Can...	G. T.	33	146	4.42
Portsmouth, Va..	S. A. L.	51	626	12.27
Brightwood, Ind.	C., C., C. & St. L.	132	2,344	17.76
Concord, N. H...	B. & M.	77	308	4.00
Albany, N. Y...	N. Y. C.	175	4.622	26.41
Oelwein, Iowa ..	C. G. W.	42	265	6.31
Topeka, Kan. ...	A., T. & S. F.	125	1.860	14.88
Middletown, N. Y.	N. Y., O. & W.	50	1,000	20.00
Baltimore Md...	B. & O.	157	5.048	32.14
Burnside, Ill. ...	I. C.	516	2,927	5.67
Collinwood, Ohio.	L. S. & M. S.	360	6,300	17.50
Springfield, Mo..	St. L. & S. F.	105	850	8.09

As it is impossible to have a very extensive repair plant and keep it close to the smith shop it will almost always pay to establish a forge close to the center of gravity of the freight car repair work, as such work always involves more or less straightening of bent forgings; this local forge is wanting in many places, but it is certainly false economy to undertake to do without it. As the materials used in freight car repairs at a central point are large in quantity and great in variety, their proper supervision becomes important, and good talent can be profitably engaged in keeping up the stock in advance of requirements and in promptly meeting all demands; this is of first importance as affecting output, but of course must be supplemented by proper records for purposes of accounting.

The advent of the steel car has not modified the practice of freight car repairs as much as was predicted. It is found that ordinary repairs to steel cars can be handled by the same class of labor that has hitherto been engaged on the repairs of wooden cars; the only special plant required includes a heating furnace, straightening blocks, clamps, a supply of compressed air and compressed air tools (riveting hammers, dolly bars, etc.). Since the more general use of electricity as a source of power it has been feasible to provide an electric traveling crane to cover a few tracks where steel cars are to be handled for repairs, and this has been done in two or three instances lately. At the new Montreal shops of the Canadian Pacific an electric yard crane crosses all tracks in the entire plant, and one of the uses to be made of it is the unloading of wrecked car material which has been sent in from the line of the road, and which it is extremely tedious and expensive to unload and sort by hand.

Although a special paint shop building is quite necessary in connection with a plant which is engaged exclusively on freight car construction, in order to secure good and durable work, yet no special provision is considered necessary in connection with a repair plant.

A special and separate wheel and axle shop can often be provided to good advantage; although this class of work is frequently done in the regular machine shop of a general railway repair plant, yet, unless the plant is small, it can usually be set apart and located more conveniently to the car repair work in connection with which it is principally used; the class of labor employed is different from that engaged on locomotive machine work, and its heavy materials (wheels, axles, etc.) usually come to it direct from outside sources. The number of pairs of wheels used under freight equipment cars at any one general repair point is always so very much greater than the number used for locomotive work, that the wheel and axle shop should properly be located and arranged with reference to the needs of the freight car repair department. Where new cars are built in considerable numbers this wheel and axle shop may be enlarged and equipped as a truck shop, or an entirely separate but contiguous truck shop put up; a truck shop should be equipped to do all necessary machine work on castings as received from the foundry and forgings as received from the smith shop; a number of such truck shops have been put up within the last few years.

The output of several freight car repair plants is given in Table 14 on the basis of a month's work, both total and per stall; the returns include light, medium and heavy repairs, but exclude running repairs; as the classification of freight car repairs is somewhat indefinite it is probable that these terms are differently interpreted in different localities, and due allowance must be made for this fact; there being no definite basis of judging of the ouput of freight car repair yards, and it being necessary to have one for purposes of comparison, it was assumed that the output of repaired cars per month per stall was the fairest criterion, and it has therefore been used, as previously done in the case of locomotives and passenger equipment cars. The table shows a great variety of repair plants with standing capacity ranging from a minimum of 33 to a maximum of 728, and other plants, not here listed, can best be compared with these by selecting those which correspond most closely in the matter of standing capacity; the outputs per month per stall also vary between very wide limits, but it is believed that when attention is once directed to these great differences it will be possible to bring the efficiency of the less productive plants up to the basis of the better ones.

As the exceptional results shown for the Oneonta shops of the Delaware & Hudson may challenge criticism, it should be

stated that they have been carefully verified; it is surprising to find that a shop as little known and so seldom visited as Oneonta should head the list for unit output. The showing of the Baltimore shop of the Baltimore & Ohio is also highly creditable. It is not known what proportion of steel cars are handled at Oneonta, but at Baltimore the facts are as follows: Of the average total of 157 cars standing under repairs, 32 are steel and 125 are wooden; of the average total of 5,048 cars turned out per month (after repairs), 472 are steel and 4,576 are wooden; the corresponding outputs per stall per month are, steel 14.75, wooden 36.61; the ratio of these two quantities is 2.48, which means that under present conditions at Baltimore it takes between two and three times as long to repair a steel car as it does to repair a wooden car. The figures in Table 14 should be followed up by investigation on the ground at the various plants, as arrangements, facilities, organization and supervision all have a bearing on the results. The outputs (total and unit) of several new plants have been predicted, but it is considered best not to state them until they can be verified by experience.

(*To be continued.*)

WATER SOFTENING ON A LARGE SCALE.

With the installation of water softening plants sufficiently numerous to provide good water for entire divisions or entire railroads the opportunity for a thorough test of the advantages of chemical treatment in roadside plants is provided. Such a wholesale and thorough equipment as that of the Pittsburgh & Lake Erie marks what seems likely to be a new epoch in this important development. In this issue the first of several articles on this equipment is presented. This road entered into a thorough investigation of its waters and of various kinds of softening apparatus, and when satisfied as to the right course to pursue, the decision to make the application a thorough one was at once followed by actual construction. The officers of this road first studied and then acted, and boldly. As to the wisdom of the course there is no doubt.

An exceedingly interesting statement has been received from the railroad officer who is most competent to judge the value of water softening for locomotive purposes, to the effect that he expects to be able to show that the reduction in the consumption of coal on divisions which are equipped with water purifiers will more than balance the cost of chemicals used in the treatment of the water. All other gains, therefore, will be "velvet." When these large installations have been in service a little longer we hope to be able to show what the other gains amount to, and it is sure to be a very fine showing for the investments in purifying apparatus.

The people who attempt to find out what there is in this question of water purification by putting up a single softening plant are like the Irishman who judged the probable comfort of a feather bed by lying upon a single feather upon the floor. He found it very hard. Now that the importance of providing against mixing treated and untreated water in locomotive tenders is appreciated, we shall undoubtedly make great strides toward improvement in the service rendered by locomotive boilers.

It is one thing for the head of a department to issue instructions to his subordinates and quite another thing to know that they are understood and carried out. One motive power superintendent requires from his master mechanics every three months a letter stating that they understand and are carrying out the instructions given in the form of "circulars of instruction," in this way hoping to keep these instructions prominently in the minds of the subordinates. Thus far it has worked very well and has had an unexpected effect in leading to a most useful method of issuing instruction circulars. The number in force has been greatly reduced and they are now kept up to date and consistently consolidated into a systematic code of working rules. This effect on the rules themselves is not the least important result of the overhauling the matter has received. Others might find advantage in a plan of this kind.

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.

PITTSBURGH & LAKE ERIE RAILROAD.

I.

The approaching completion of the new locomotive repair shops of the Pittsburgh & Lake Erie at McKees Rocks, Pa., is of interest and importance to those interested in railroad-shop development, as many radical improvements and advances have been incorporated which will place them in a prominent position as representative of the very latest practice. It is with pleasure that we are permitted, by the courtesy of the officials in charge, to present a description of the shop equipment and buildings, which will follow in a series of articles as the different departments are completed and go into service.

The most remarkable feature of these new shops is the magnitude of the locomotive repair department, which is the portion that is at present nearing completion. It is seldom that a railroad having less than 200 miles of track may be found operating over 200 locomotives; such is the case, however, upon the Pittsburgh & Lake Erie, which, with a total length, main line and branches, of only 194 miles, has considerably over 200 locomotives in use. The result of the very heavy traffic which requires so large an equipment is to impose peculiar and unusual operating conditions which are not to be found elsewhere. This accounts for the installation of a locomotive shop of sufficient size to handle the repair work of a road of from 750 to 1,000 miles in length, operating under ordinary conditions.

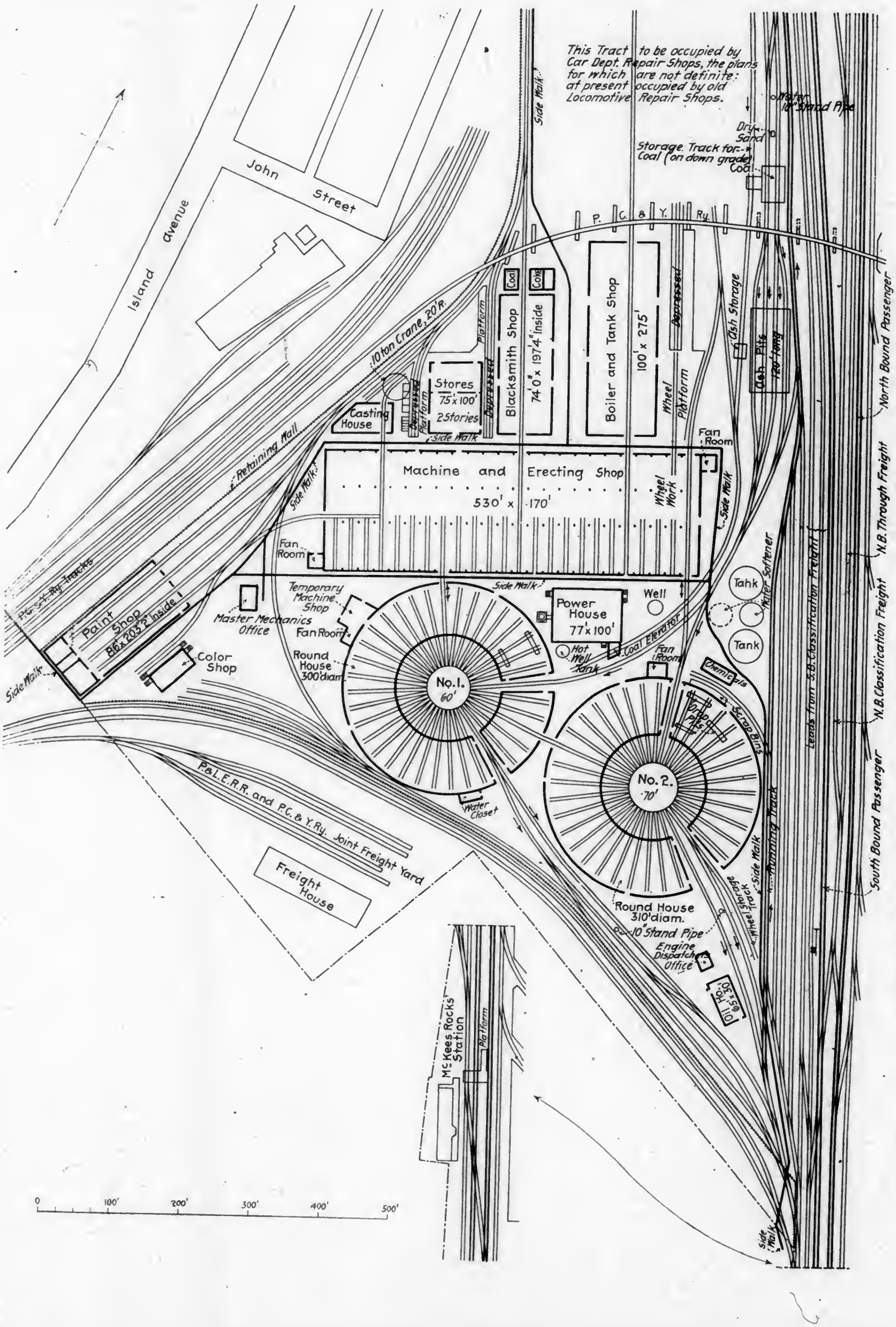
CHARACTERISTICS OF THE ROAD.

The Pittsburgh & Lake Erie operates as a connecting link between the steel-mill and coal and coke industries of the Pittsburgh region and the large trunk railroads and lake shipping interests in the vicinity of the Great Lakes to the north; it also serves as the Pittsburgh connection of the New York Central lines. The most important freight traffic of this road is the movement of coal and coke from the Youghiogheny and Monongahela divisions of the road, south of Pittsburgh, to the north to the trunk lines and lake shipping, this traffic comprising over one-third of the entire freight business of the road. Another very large proportion of the freight traffic is the heavy shipments of iron ore from points on Lake Erie to the many blast furnaces in the Pittsburgh region.

An idea of the magnitude of the traffic may be had from the fact that a total car movement of 9,000 cars per day has been reached, for a maximum, the average daily movement of cars being in the vicinity of 7,000 cars. The total car mileage for the last twelve months has aggregated 98,789,694 miles. The effect of these enormous movements of freight both north and south, together with that of a heavy passenger traffic, is to make necessary the maintenance of a very large rolling equipment.

The freight equipment of the road consists of 11,800 cars, and the heavy passenger traffic requires over 100 passenger cars. Of the total of over 200 locomotives, 96 are heavy consolidations; 52 of these have total weights of 192,000 lbs. and tractive efforts each of 44,100 lbs. The rated load for the heavy consolidations is 3,500 tons, the maximum ruling grade of the system being 16 ft. to the mile, but they cannot always be run fully loaded, as the maximum train length permitted is 80 cars. To handle this extremely heavy service over 350 engineers and about the same number of firemen are constantly employed.

The road is double-tracked throughout its length and is four-tracked in many of the sections where the traffic is most dense. The entire system is fully protected by automatic electric block signals. The entire equipment of the road is most complete and modern, and the effort made is to render the service more efficient and productive as the business increases, rather than congested and delayed in periods of heavy business. This most progressive policy is due to the efficient management of



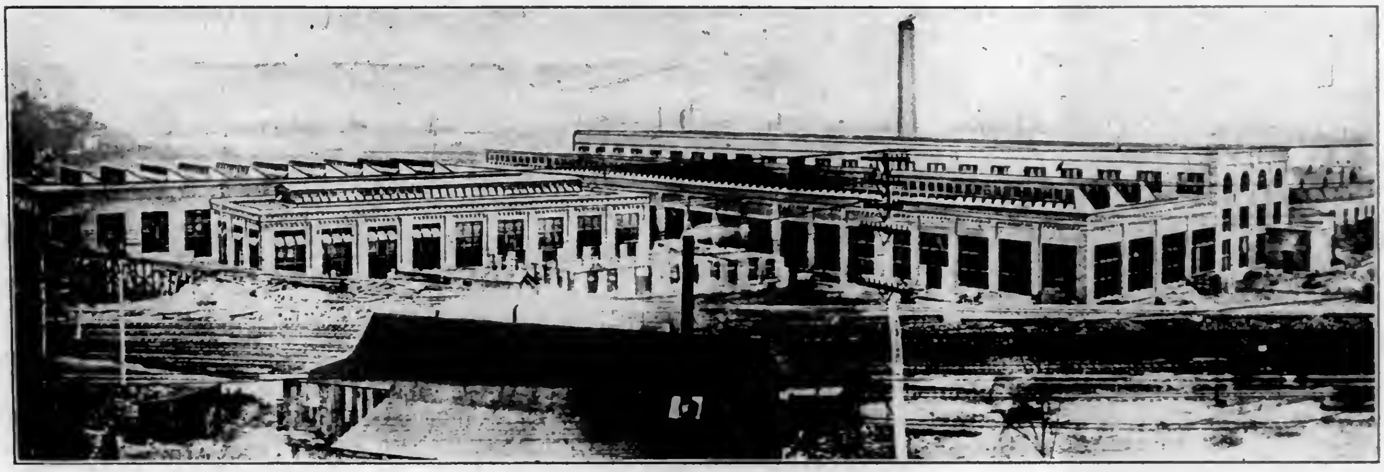
NEW LOCOMOTIVE SHOPS AT McKEES ROCKS, PA.,—PITTSBURGH & LAKE ERIE RAILROAD.

L. H. TURNER, *Superintendent Motive Power.* J. M. SCHOONMAKER, *Vice-President and General Manager.* J. A. ATWOOD, *Chief Engineer.*

R. V. WRIGHT, *Mechanical Engineer.* A. R. RAYMER, *Assistant Chief Engineer.*

Mr. J. M. Schoonmaker, vice-president and general manager, and the results of his progressive management tend to verify the saying that "the best is the cheapest in the end," inasmuch as the last annual report of the P. & L. E. indicated a gross earning last year of $54,000 per mile of track operated, as against the average earnings of $10,000 to $20,000 per mile upon other roads. These important features of this road are phenomenal and rare.

The most important of the many improvements now under way upon the P. & L. E. is the new repair-shop installation at McKees Rocks, Pa., which is rapidly approaching completion. The larger buildings of the locomotive-repair department, including the combined erecting and machine shop, the boiler shop and the blacksmith shop, are ready for occupancy, and the necessary machinery is being installed. The power plant has been in operation for some time. It will be several months, however, before the shops will be ready for complete operation in all departments; the storehouse building is not yet completed, and the casting-house has only the foundation laid at this time.



VIEW OF PLANT LOOKING EAST AND SHOWING GENERAL CHARACTER OF THE BUILDINGS.

LOCATION OF THE SHOPS.

In rebuilding the shops it was thought best to locate them upon the site of the old shops at McKees Rocks, as the most favorable point upon the road for the purpose. McKees Rocks is the nearest yard and roundhouse site available to the Pittsburgh terminal, on account of the limiting conditions of the country in the vicinity of Pittsburgh. The Monongahela River on one side and a steep bluff several hundred feet high on the other side absolutely prohibited locating the shops nearer the city, but the distance from the terminal to the site occupied, 4½ miles, is not prohibitive. The site chosen is also the natural division point, as the main line and the Youghiogheny division (which includes the Monongahela division) center at Pittsburgh, with 81 miles (the main line and branches) to the north and 113 miles (the Youghiogheny and Monongahela divisions) to the south. Several tributary roads for which locomotive-repair work is done also have terminal connections with the system at Pittsburgh, so that easy access is afforded to the shop site. In this way practically all of the engines of the system pass the main shop on every round trip, and thus no time can be lost in going to and from the shops.

GROUND PLAN.

The new shops are being rebuilt upon the site of the old shops, the new locomotive-department buildings being located upon the site of the old car-shop buildings, which were removed to permit the new construction. The old locomotive-department buildings, which have not yet been entirely vacated, now occupy the site upon which the new car shops will be built, the details of which have not as yet been definitely decided upon. The general arrangement of the locomotive-shop buildings, upon the south end of the shop site, and the tracks serving them, is indicated in the accompanying full-page ground plan, which shows how well the limited tract of ground available has been utilized. The width of the tract was limited by the main line on the east and other railroad property on the west, and the length is limited, but a most convenient arrangement of building has been worked out.

The combined locomotive erecting and machine shop is situated to the north of the roundhouses, and the boiler shop and the blacksmith shop are located beyond it and adjacent to the trestle which carries the Pittsburgh, Chartiers & Youghiogheny Railway, a tributary line, across the shop site. The location of the main erecting shop provides, by virtue of the transverse arrangement of the pit tracks, easy access for engines entering from the roundhouses; a direct-connecting

FLOOR AREAS OF THE BUILDINGS.

	Square Feet.
Erecting shop (530 x 70)	= 37,100
Machine shop (530 x 100)	= 53,000
Boiler and tank shop (275 x 100)	= 27,500
Blacksmith shop (200 x 75)	= 15,000
Total locomotive shops	= 132,600

	Square Feet.
Storehouse (100 x 75)	= 7,500
Casting house (90 x 40)	= 2,800
Power plant (100 x 77)	= 7,700
Paint shop (205 x 85)	= 17,425
Color shop (60 x 30)	= 1,800

PERCENTAGES OF LOCOMOTIVE DEPARTMENT SHOPS.

	(Total, 132,600 Sq. Ft.)
Erecting shop	28.0%
Machine shop	40.0%
Boiler and tank shop	20.7%
Blacksmith shop	11.3%
	100.

FLOOR AREA OF VARIOUS DEPARTMENTS PER PIT IN THE ERECTING SHOP.
(Total number of erecting pits, 22.)

	Square Feet.
Erecting shop	1,686
Machine shop	2,409
Boiler and tank shop	1,250
Blacksmith shop	681

DISTANCES OF TRAVEL BETWEEN CENTERS OF SHOP BUILDINGS.

	Feet.
Erecting shop to machine shop	85
Erecting shop to boiler and tank shop	450
Erecting shop to blacksmith shop	275
Erecting shop to storehouse	295
Totals	1,105
Machine shop to erecting shop	85
Machine shop to boiler and tank shop	365
Machine shop to blacksmith shop	190
Machine shop to storehouse	210
Totals	850
Boiler and tank shop to erecting shop	450
Boiler and tank shop to machine shop	365
Boiler and tank shop to blacksmith shop	175
Boiler and tank shop to storehouse	325
Totals	1,315
Blacksmith shop to erecting shop	275
Blacksmith shop to machine shop	190
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Totals	790
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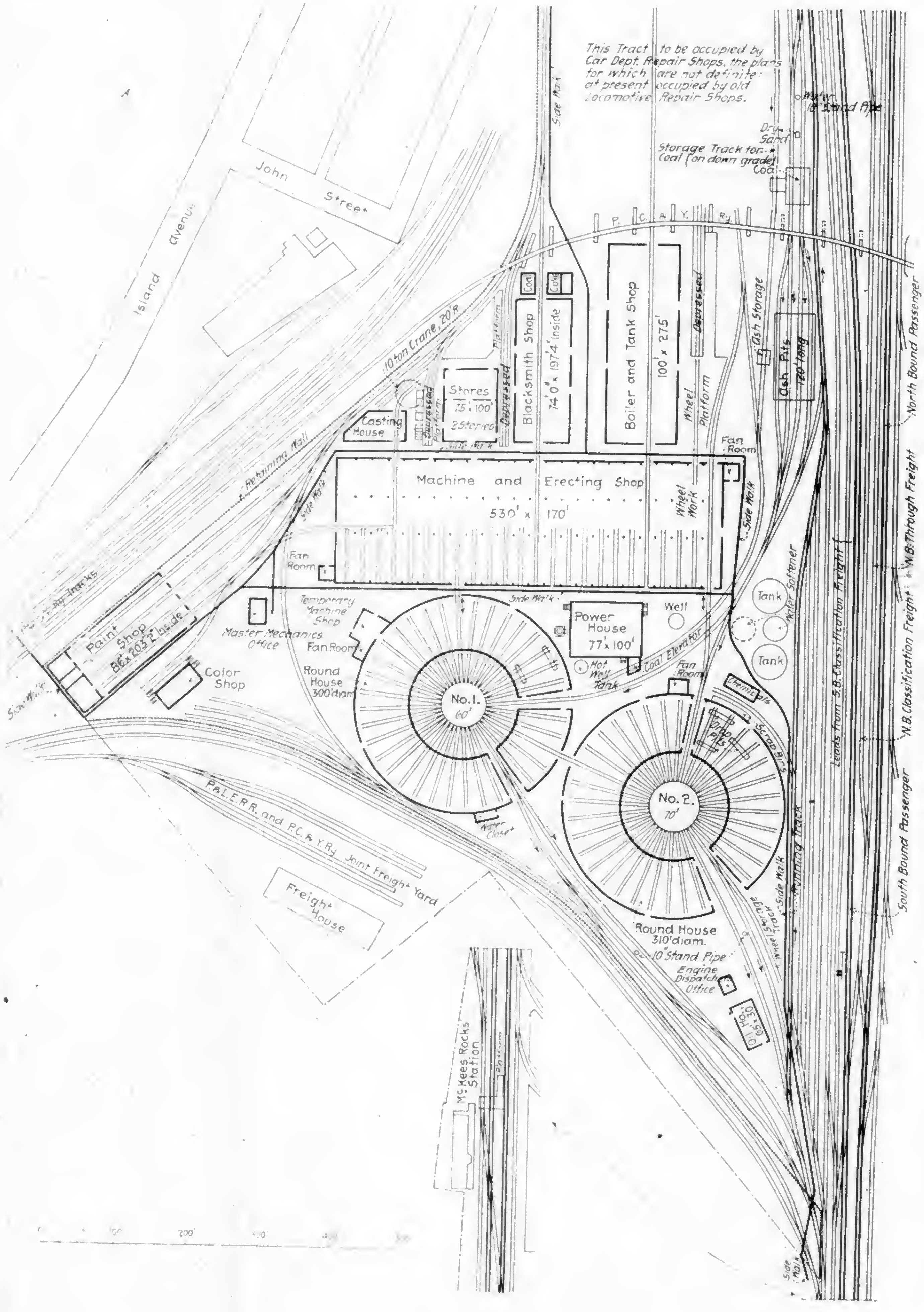

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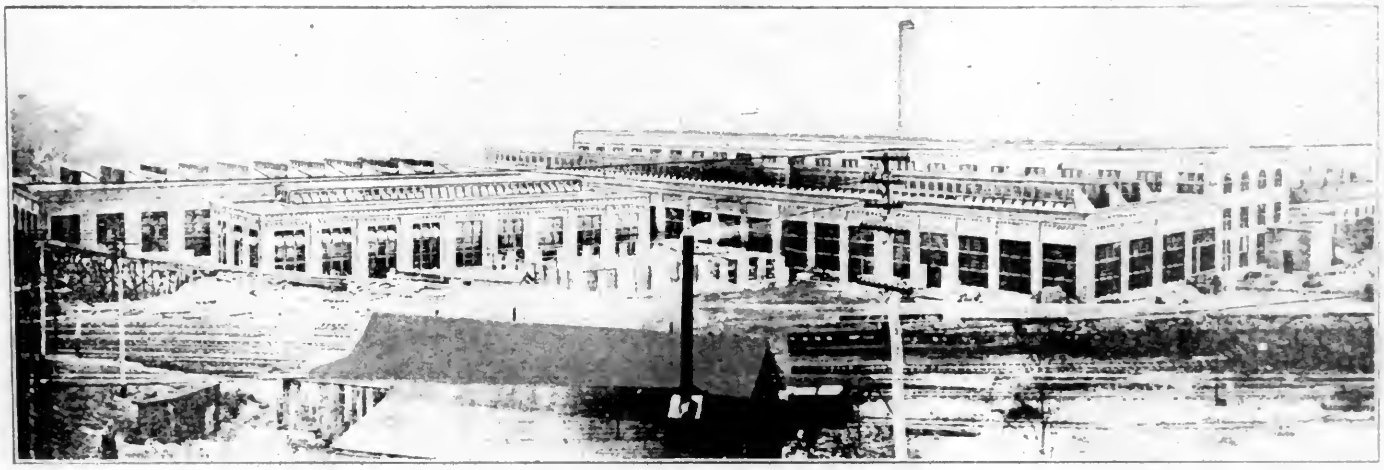

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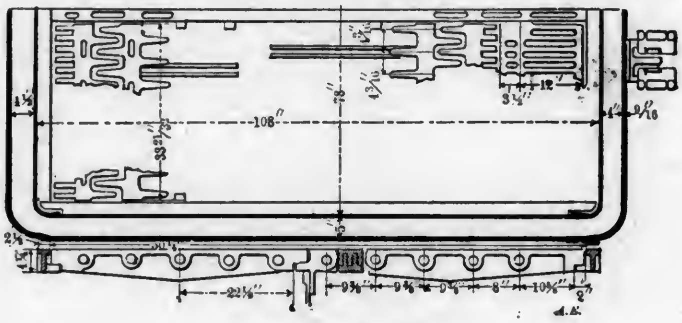
track leading in from either roundhouse. The boiler and smith shops, as well as the casting house, have direct track connections with the main shop, and the storehouse is liberally provided with track facilities. The result of the arrangement chosen is to render the distances for moving material much shorter and more direct than is possible with most shop layouts, and still ample space and convenient passageways between the buildings are provided.

The power plant is located very close to the center of power consumption, which lies in the locomotive erecting and machine shop (always the governing factor in the railroad shop problem), and also is most conveniently arranged for operating the water supply system and the new hot-water boiler washing system to be installed in the roundhouses. In this way its location is ideal. This location also provides easy access for the side-track leading to the coal and ash-handling apparatus for the power house, which is so arranged as to avoid all manual handling.

CAPACITY AND EXTENSION OF PLANT.

The capacity for which the locomotive shops were intended was that of taking care of the heavy repairs for all the locomotives of the system, over 200 in all, each of which is to pass through the shops once per year. This has been amply provided for, inasmuch as there are 22 pits in the erecting shop, constantly available for repair work (the other two pits of the 24 being reserved as entering tracks), and, as may be noted in the accompanying table, a very large proportion (40 per cent.) of the total locomotive department shops is devoted to machine shop work. This will permit the entire locomotive equipment to be taken care of very easily, as with the present number, only about 10 locomotives will need to be repaired per pit per year, to pass all of them through the shop; this is equivalent to about 33 days in the shop for each locomotive, which is a very liberal allowance with the modern conveniences in repair shop work. It is expected, however, that, with the facilities that will be provided, about one-half of this time will be required per engine.

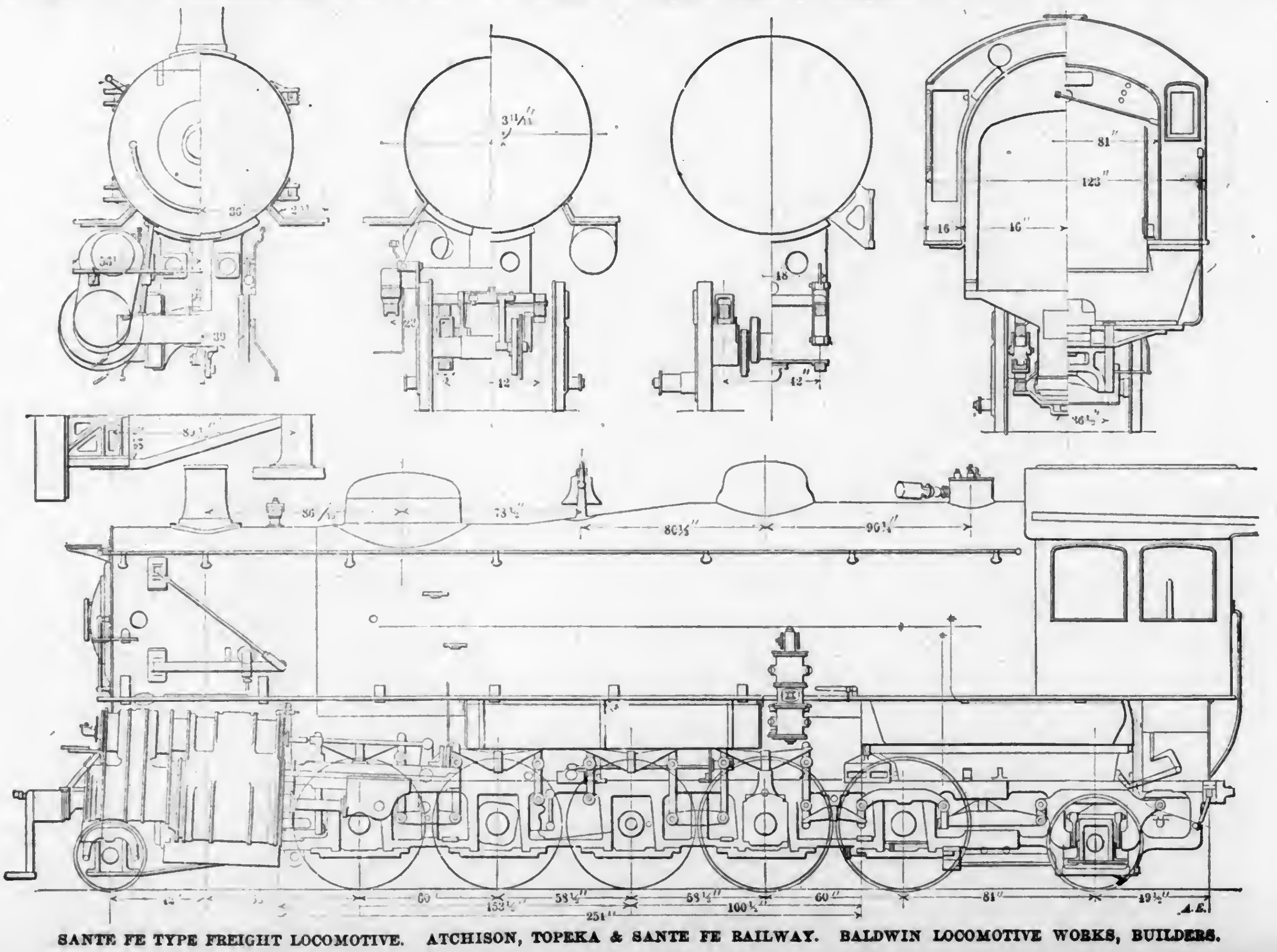
A system of standardization of locomotive parts and details is gradually being worked into the motive-power department of this road, which will greatly facilitate the work of effecting repairs to locomotives. Many of the older locomotives of the small sizes are being disposed of, and the new locomotives purchased are carefully designed to conform to the standard designs of parts and details that are now being worked to. This system of standardization is to be extended later to cover the storage of duplicate parts for all locomotives in the storehouse, where they will be kept always in stock ready to be drawn out upon proper requisition. In this way, after a locomotive is stripped for general repairs, it need only



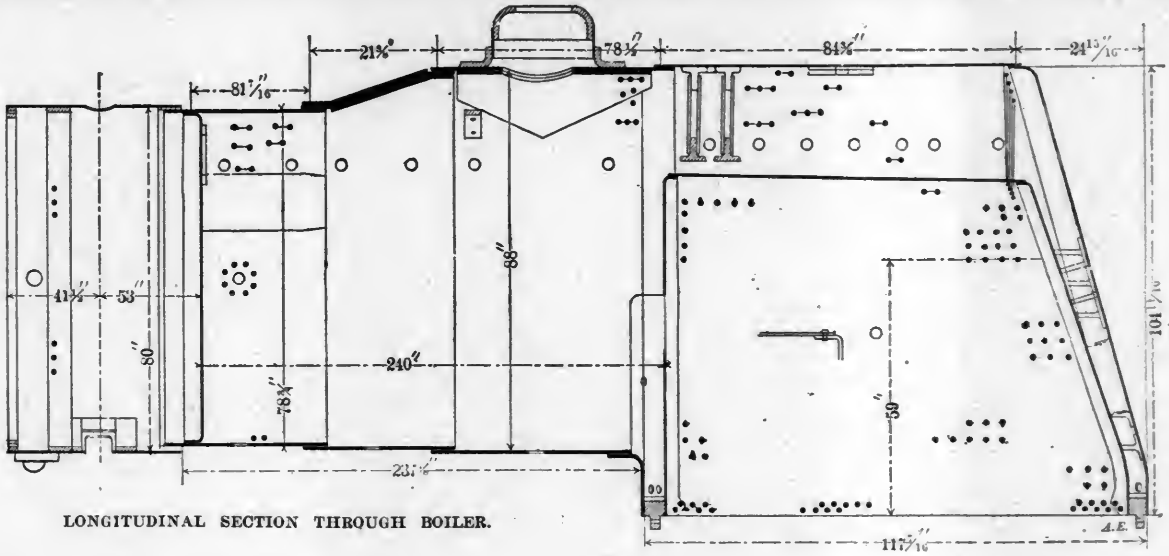
PLAN OF GRATES.

wait for the repair parts to be drawn out of the storehouse upon requisition for re-erecting, and no delay is caused by waiting for repairs to dismantled parts, which, after necessary repairs, are merely returned to the storehouse.

This method of handling the work of repairing, involves in itself a reserve capacity for the shop, the extent of which it is hard to estimate. It is safe to say, however, that the time required per engine on the pit may be cut down sufficiently to permit double the present locomotive equipment to be handled by the repair shop facilities now being installed—thus, it may be seen that the general scheme of the shops provides repair facilities adequate to take care of an enormous growth of the road.



SANTE FE TYPE FREIGHT LOCOMOTIVE. ATCHISON, TOPEKA & SANTE FE RAILWAY. BALDWIN LOCOMOTIVE WORKS, BUILDERS.



LONGITUDINAL SECTION THROUGH BOILER.

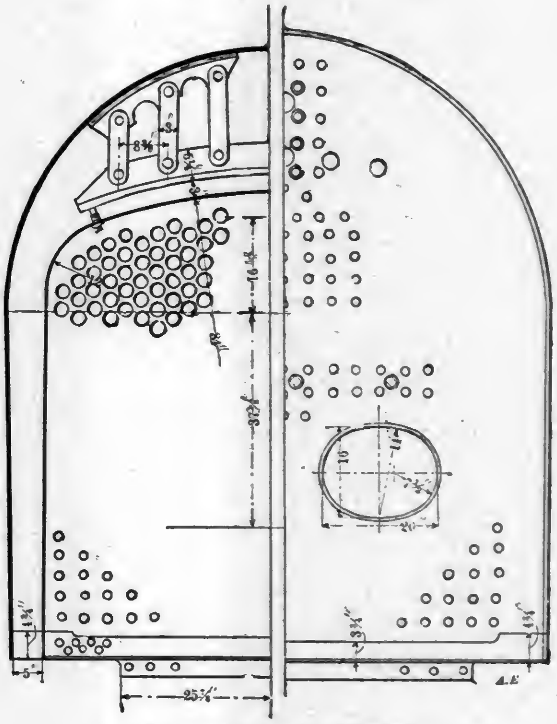
THE HEAVIEST LOCOMOTIVE EVER BUILT.

ATCHISON, TOPEKA & SANTE FE RAILWAY.

SANTE FE (2-10-2) TYPE, TANDEM COMPOUNDS.

Because of their enormous proportions and the large number ordered this is the most remarkable locomotive design of the year. A photograph and table of dimensions appeared on page 372 of our October number. The type of wheel arrangement is believed to be new. The engines are similar in many respects to the decapod or 2-10-0 type, illustrated on page 190 of our issue of June 1902, with the addition of a pair of trailing wheels, an addition of about 20,000 lbs. in total weight and some changes in the boiler. These engines are capable of exerting a tractive effort of 69,500 lbs. in starting and 62,800 lbs. when running as compounds. They are equivalent to simple locomotives with 25.44 and 24.22 in.-cylinders respectively, in starting and in running. In the construction of the cylinders no material changes have been made from the decapod design. By aid of the accompanying table comparisons may be made between this and other recent heavy locomotives.

In the table will be found two 2-10-0 design of tandem compounds built for this road by the Baldwin and American locomotive works. Three of these engines have been in service for a year and a half. They have 232,000 and 237,000 lbs. on



SECTION AND END OF FIREBOX.

COMPARATIVE TABLE OF DIMENSIONS OF HEAVIEST FREIGHT LOCOMOTIVES.

Type—Drivers	4-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-10-0	2-8-2	2-10-0	2-10-2
Type—Name	Mastodon	Consol.	Consol.	Consol.	Consol.	Decapod	Mikado	Decapod	Santa Fe
Name of railroad	Ill. Cent.	L. V.	N. Y. C	Union	B. & L. E.	A., T. & S. F.	A., T. & S. F.	A., T. & S. F.	A., T. & S. F.
Number of road or class	640	......	G-4	95	150	989	900	987	915
Builder	Brooks	Baldwin Vauclain	American	Pittsburgh	Pittsburgh	American	Baldwin Vauclain	Baldwin Tandem	Baldwin Tandem
Simple or compound	Simple	Compound	Tandem C	Simple	Simple	Tandem C	Compound	Compound	Compound
When built	1899	1898	1903	1898	1900	1902	1902	1902	1903
Weight, engine total, lbs	221,450	225,082	227,000	230,000	250,300	259,800	261,720	267,800	287,240
Weight, on drivers, lbs	181,400	202,232	201,000	208,000	225,200	232,000	199,670	237,800	234,580
Weight, on leading truck, lbs	40,050	22,850	26,000	22,000	25,100	27,800	27,250	30,000	23,420
Weight, on trailing truck, lbs	......	......	......	......	......	......	34,800	......	29,240
Weight of tender (loaded), lbs	147,600	121,000	133,850	104,000	141,100	134,900	162,000	......	162,000
Wheel base, driving, ft. and ins.	15-9	15-0	15-0	15-7	15-7	20-0	16-0	20-4	19-9
Wheel base, total, engine, ft. & ins.	26-6	23-10	23-7	24-0	24-4	28-11	31-6½	29-10	35-11
Wheel base, total engine and tender, ft. and ins	60-2½	55-0½	59-1	54-9½	57-11¾	62-0	62-0	59-6	66-0
Driving wheels, diameter, ins	57	55	51	54	54	57	57	57	57
Cylinders, diameter, ins	23	18 & 30	16 & 30	23	24	17½ & 30	18 & 30	19 & 32	19 & 32
Cylinders, stroke, ins	30	30	30	32	32	32	32	32	32
Heating surface, firebox, sq. ft.	263	215	201	205	241	205.4	210.3	210.3	210.0
Heating surface, arch tubes, sq. ft.	......	......	26	......	......	......	......	23.9	......
Heating surface, tubes, sq. ft.	3,237	3,890.6	3,915	3,116.5	3,564	4,476.5	5,155.8	5,155.8	4,586
Heating surface, total, sq. ft.	3,500	4,105.6	4,142	3,321.5	3,805	4,681.9	5,366.1	5,390	4,796
Firebox, length, ins	132	120	105	120	132	108 1-16	108	108	108
Firebox, width, ins	41½	108	79	40.5	40.25	79¼	78	78	78
Grate area, sq. ft.	37.5	90	58	33.5	36.8	59.5	58.5	58.5	58.5
Boiler, smallest diameter of, ins.	80⅛	80	77	80	84	78¾	78¾	78.75	78.75
Boiler, height of center above rail, ft. and ins	9-8	8-7⅝	9-3	9-3⅝	9-11¾	......	9-10	......	......
Tubes, number & diameter in ins.	424-2	511-2	507-2	355-2¼	406-2¼	413-2¼	463-2¼	463-2¼	391-2¼
Tubes, length, ft. and ins	14-8⅝	14-7¾	14-9	15-0	15-0	18-6	19-0	19-0	20
Steam pressure, lbs., per sq. in.	210	200	210	200	220	225	225	225	225
Type of boiler	Belpaire	Wootten	Extended Wagon top	Straight	Straight	Extended Wagon top	Wagon top	Wagon top	Wagon top
Fuel	Bitum. coal	Ant. coal	Bitum. coal	Bitum. coal	Bitum. coal	Feb., 1902	Bitum. coal	Bitum. coal	Bitum. coal
Reference in American Engineer and Railroad Journal	Oct., 1899 P. 315	Dec., 1898 P. 395	May, 1903 P. 174	Nov., 1898 P. 365	July, 1900 P. 214	Oil P. 38	Jan., 1903 P. 16 and Mar., 1903 P. 109	June, 1902 P. 192	Nov., 1903

driving wheels, and are giving most satisfactory results except that they will not run backward down a curved hill without derailing. This is because of the lack of trailing wheels to guide them. Later the 2-8-2 type appeared. These originally had 200,000 lbs. on the 8 driving wheels, which was raised by traction increasers to 230,000 lbs. In the new engines the latter weight on drivers was desired, but without resorting to the use of traction increasers. Hence the new 2-10-2 design.

SANTE FE TYPE TANDEM COMPOUND LOCOMOTIVE.

ATCHISON, TOPEKA & SANTE FE RAILWAY.

RATIOS.

Heating surface to volume of high pressure cylinders	= 456.
Tractive weight to heating surface	= 49.
Tractive weight to tractive effort	= 3.73
Tractive effort x diameter of drivers to heating surface	= 746.
Heating surface to tractive effort, per cent	= 7.6
Total weight to heating surface	= 59.89

This table shows that the new design is 20,000 lbs. heavier in total weight than the 2-10-0 already referred to, while the weight on driving wheels is a trifle less. Instead of 5,390 sq. ft. of heating surface, the new one has 4,586 sq. ft., the diameter of the boilers being the same. But the new boilers are longer, the tubes are 20 ft. long and of the same diameter, 2¼ in. In the new boiler there are 391 tubes as compared with 463 of the earlier engine. This should result in freer circulation. In the new boiler the water spaces in front, sides and back of the firebox are 4½, 5 and 4 in. respectively. This additional space, particularly at the sides is a commendable improvement. While there seems to be a considerable sacrifice of heating surface in these new boilers the step toward providing better circulation is undoubtedly in the right direction, especially on a road having such bad waters as the Sante Fe. These boilers are supported by plates at the back end, and by sliding supports on cross frame braces at the front end of the firebox. The longitudinal seams are welded for 14 in. at the front end and 9 in. at the back end of the first course; 9 in. at each end of the taper course and the whole seam is welded on top of the third course. The drawings show that there are 14, 1⅛-in. stays, 1,322, 1-in. stays and 272 special 1-in. stays with interrupted threads. These boilers have two firedoors.

In the cylinder construction and the arrangement of valves the previous design has been closely followed. The engravings of these parts are not repeated, for this reason. The center line of the cylinders is inclined 1 in. in 24 in., the line meeting the center line of the driving wheels at a point 7-in. back of the fourth driving axle. For the joint between the high and low pressure steam chests a packed gland is used as before. This also applies to the steam pipe connection for the high pressure cylinders.

In another issue detail drawings of the frames, crossheads, crank pins, rods and driving wheels will be presented.

AN EXTENTIVE WATER SOFTENING INSTALLATION

TOTAL CAPACITY 348,000 GALLONS PER HOUR.

PITTSBURGH & LAKE ERIE RAILROAD.

There is at this time no problem directly connected with the operation of railroads so vitally important to transportation and which so intimately affects desired results as that of supplying satisfactory water for locomotive boilers. This came to be appreciated when the abnormal conditions of business during the past three years taxed to the utmost all facilities for moving traffic. There is now no feature of locomotive operation and construction which constitutes so great a problem as the maintenance of boilers, and this is intimately associated with and affected by the character of the feedwater. The trouble is serious and justifies elaborate and necessarily expensive measures for improvement. The time for imperfect and incomplete methods, such as by using "boiler compounds" in any form, or by using any treatment wherein the precipitation of the scale-forming solids is not accomplished and the material removed from the water before the water is delivered to the locomotive tender has passed and important roads with heavy traffic must meet the issue squarely. This the Pittsburgh & Lake Erie officers have done, and it is a privilege to place on record the bold and broadminded plan which is now nearly consummated on this road.

The tendency in general has been to make trial or sporadic applications. This road, after a complete and thorough study of the chemistry of its waters, and after becoming satisfied as to the means to be employed, determined to equip at once the entire road, so that no locomotive would take other than treated water. Such a step has never been taken before, and the results already obtained show the wisdom of the decision and of the methods employed.

This road, with a total of 194 miles of track, has more than one locomotive per mile and deals with a dense traffic in coal, ore and steel products, centering in Pittsburgh, which is best shown by the statement that the car mileage for the last twelve months has aggregated 98,789,694 miles.

For water supply it is dependent chiefly upon the Ohio, the Monongahela and the Youghiogheny rivers. The difficulty with the waters is due not only to excessive sediment, but also to scale-forming salts, and, in some cases, to free sulphuric acid. The result of the use of this water in boilers in the enormous quantities required to haul the train loads of 3,500 tons rendered the problem a serious one. Large numbers of locomotives were, as a consequence, out of service because of flue and firebox leakage and other bad-water troubles. New flues in new locomotives had under these conditions to be replaced on an average after ten months' service. At times from 30 to 50 per cent. of the total locomotive equipment would be laid off at one time for flue work. During the bad-water season quite frequently locomotives would "die" on the road, due to excessive firebox leaks. This resulted in serious interference with traffic. This is not surprising, in view of the fact that the water supplied, for example, from the Youghiogheny River contained 15 to 20 grains of free sulphuric acid per gallon, and other waters contained much scale-forming solids.

The crisis in the water question came during the freight congestion of last year and proved an incentive for investigation of the possibilities of chemical treatment for the removal of acid and of the scale-forming impurities from the water before it entered the boilers.

This work was undertaken by employing an expert chemical engineer to determine the treatment necessary to transform the available water supply into good boiler feed-water, and then to devise or to find a treating plant that would measure up to the requirements. With this object in view, the different plants on the market designed for this purpose were examined, analyses of "raw" and of "treated" waters in each case were made to determine the work being done, and a comprehensive report was made in each case, measuring up each plant with the ideal plant, thereby showing clearly the good and the bad points of each.

It may be said that in treatment of waters for the removal of scale-forming solids, all chemical engineers agree on the use of lime water for the removal of carbonate of lime and of magnesia, and of soda ash for the removal of sulphates of lime and of magnesia, and most of them advocate the use of soda ash to neutralize sulphuric acid. Therefore, in choosing between the different purifying plants on the market it was not a question of difference in treatment, but entirely a question as to merit in mechanical design to accomplish certain fixed chemical results. Some of these requirements may be stated as follows:

1.—The delivery of the chemicals used in solution at desired rates in proper proportions to variations in volume of raw water pumped. The chemicals should be so delivered that the proportions will hold accurately through variations from "no flow" to maximum capacity of plant, so that the operator who has charge of the pumping plant, as well as of the puri-

fying plant, may start and stop the pump without interfering with the proper purification of the water.

2.—The chemicals and the raw water must be thoroughly mixed.

3.—A sufficiently large chamber must be furnished to hold the water while the chemical reactions are taking place.

4.—The sedimentation chamber must be large enough to allow time in the "continuous process" for good precipitation, which should be in the presence of old sediment.

5.—Proper precautions must be taken to prevent the water at any stage in the treatment from "by-passing" or going ahead of water previously delivered in any of the chambers—that is, each unit of water should be made to follow, as far as possible, the preceding unit continuously through the plant.

6.—The water should be passed through an easily cleaned filter before leaving the plant.

7.—As small a quantity of purified water as possible should be wasted when the filter is washed.

8.—The plant should have good construction details, easily protected from frost. No parts not easily kept in repair, should be compact, and occupy small ground area.

The purifying plant chosen for use on this railroad by the above method, as measuring up most nearly to the ideal requirements, was that manufactured and erected by the Kennicott Water Softener Company, of Chicago.

An idea of the character of the waters to be dealt with may be had by examining the results of analyses of some of the "raw" water to be treated.

ANALYSIS OF WATER—M'KEES ROCKS.

	Parts per 100,000. "Raw."
Carbonate of lime	18.57
Carbonate of magnesia	1.62
Carbonate of soda	None
Sulphate of lime	21.78
Chloride of lime	.87
Chloride of magnesia	1.02
Chloride of soda	3,71
Sulphate of soda	None
Total	47.57

ANALYSIS OF WATER—NEW CASTLE JUNCTION.

	Parts per 100 000 "Well."	"River."
Carbonate of lime	6.61	3.75
Carbonate of magnesia	1.51	1.34
Carbonate of soda	1.69	3.77
Sulphate of lime	8.51	1.94
Sulphate of magnesia	4.02	1.75
Sulphate of soda	.00	.00
Chloride of magnesia	.00	.64
Chloride of soda	3.31	.73

ANALYSIS OF WATER—PITTSBURGH POWER HOUSE.

	Parts per 100,000 "Well."	"River."
Oxide of iron	1.64	0.48
Carbonate of lime	24.59	Trace
Carbonate of magnesia	1.51	....
Carbonate of soda	1,71	0.42
Sulphate of lime	....	7.51
Sulphate of magnesia	10.32	2.93
Sulphate of soda	6.89	1.50
Chloride of lime	9.58	....
Chloride of soda	20.42	0.99
Nitrate of sodium	Present in small amount	
Total	76.66	13.83

In treatment of water containing carbonates by use of lime water, the carbonates are removed and nothing remains in the water; but in the action of soda ash on the sulphates of lime and magnesia, and also on sulphuric acid, each grain of sulphate or of sulphuric acid removed is replaced by a grain of sulphate of sodium, which salt is soluble and remains in the water. This soluble salt does not produce any scale, but as it is concentrated in the boiler by evaporation, "foaming" or "priming" results. The amount of concentration that will cause this trouble depends in a large degree on physical conditions. It has been found that when treated water is used exclusively in a boiler, and where no impurities in suspension are present (either dirty water or disintegrated scale), the concentration may be very high before trouble will result; on the other hand, where solids in suspension are mixed with treated water in a boiler, foaming will result much more quickly. For this reason it was decided that best results could be had only by treating all the water used.

Following out this idea, treating plants have been built at all the water stations where "road" engines are supplied with water. These plants are located as follows:

Location.	Capacity in Gallons Per Hour.
McKees Rocks	60,000
Haselton	42,000
New Castle Junction	42,000
Rock Point	42,000
Stobo	42,000
Groveton	42,000
Williamsburg	21,000
Buena Vista	21,000
Whitsett Junction	21,000
Pittsburgh Terminal Station	15,000

At McKees Rocks, Haselton, Williamsburg and Whitsett Junction the plants have been completed and in operation for some time, while those at Stobo and Rock Point and Buena Vista have just gone into service. The remaining three plants will be completed and ready for operation before winter.

This indicates the magnitude of this installation and also the importance of the results to be expected. Thus far the results have been far beyond expectations, and in many ways they are surprising. Details of the plant and methods, together with observed effects upon the condition of the boilers, will be presented in other articles on this interesting subject. The plant also includes a new method of washing out the boilers.

(To be continued.)

EFFECT OF HEAT ON STAYBOLT BREAKAGES.

In one of the discussions before the recent Master Mechanics' Convention, Professor Hibbard referred to some interesting staybolt experiments as follows:

I would like to tell of some tests we made recently regarding the effect of increasing temperatures upon the life of staybolts. The reason why we started these tests was because it is a well-known fact that if you bend the metal or hammer it, or do anything else of the sort to it while it is at the blue temperature, which is commonly considered to be the temperature between that of boiling water and that at which if you sprinkle hardwood sawdust on the metal it will ignite—we wanted to carry out some tests on staybolts to see whether the increasing steam pressures up to 300 pounds per square inch would cause the staybolts to become more brittle, because of their being at the blue temperature, as we supposed. I had for some years imagined that the increasing pressures of modern boilers would cause staybolts to be somewhere near the blue heat, and thus cause them to be more brittle and perhaps make staybolts more likely to break as we increased boiler pressures. We rigged up a machine to test them and we endeavored to come close to making the test correspond in the various conditions to the actual working conditions of staybolts in locomotive boilers; namely, we took a thin piece of boiler steel and a thick piece, to represent the inner and outer sheets. We screwed a staybolt into these two sheets and riveted it there so it would be like service conditions. Then we immersed the staybolt in a bath of hot oil, the temperature of which we controlled by a gas flame, and found its temperature by a thermometer, continuously, then put the staybolt in it, the tension corresponding to the tension at the different steam pressures at which we wished to test the various staybolts, and then vibrated the two sheets so that the staybolt would bend ¼ in. up and ¼ in. down, like the tests commonly carried out on staybolt iron at Altoona. We furthermore fastened the sheets in such a way that the space for the staybolts would be about 4 ins. apart, taking that as a standard. This much for the description. On testing the staybolts at temperatures corresponding to atmospheric steam pressure, with a long jump up to 160 lbs. of steam, and then varying by small increments of steam pressure up to 300 lbs., we found what to me was a surpising fact, namely, that the increase of steam pressure, resulting in an increase of heat, did not cause the staybolts to become more brittle as you increased the steam pressure, but caused them to be more ductile, just the reverse of what we expected.

Mr. A. L. Robinson has been appointed master mechanic of the Southern Railway, with headquarters at Princeton, Ind.

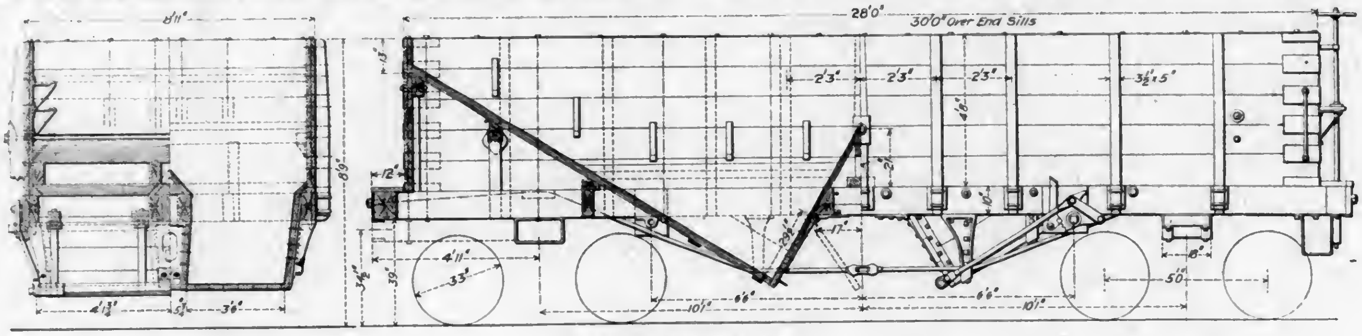
STEEL CAR DEVELOPMENT.

PENNSYLVANIA RAILROAD.

II.

(For Previous Article see Page 352.)

Because of the influence of its design upon present practice in steel coal cars, the wooden GG car is illustrated for the purpose of placing it in this record. This was a very successful design and many cars of this type are now running. It has twin hoppers and a total cubical capacity of 1,108 cu. ft., the weight being 35,200 lbs. The drawing shows the underframe, the form of the hoppers, the arrangement of the doors and other features to which it is not necessary to direct attention in detail.

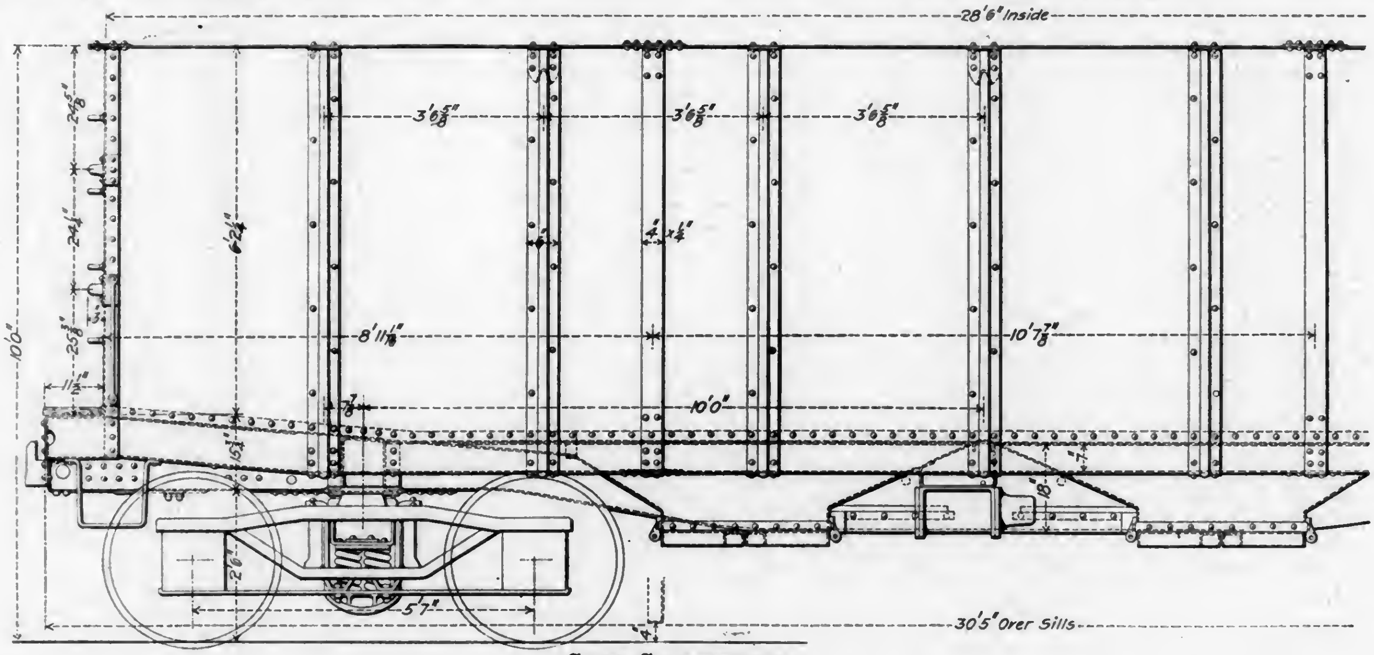


CLASS GG WOODEN CAR.

The transition from this to a similar car in steel was a simple and easy one, but on the Pennsylvania there was an intermediate design, the GM cars, of which five were built by Mr. Schoen in 1896. This is an exceedingly interesting car from a structural point of view, because, being the first steel car for the Pennsylvania, it embodied what are now considered as the most advanced ideas as to the omission of side sills and the utilization of the sides of the car as plate girders to aid in carrying the load. Undoubtedly this fact has been rather generally forgotten, because the GM car did not become a widely used standard on this road. The reason had to do with traffic rather than construction. A self-clearing car was wanted in coal service, and before the Pennsylvania Railroad was ready with a design of the same sort for that form of car, the pressed steel car presented itself and found ready acceptance in the form of the GL car, which will be presented in another article. The GM car weighed less than any 50-ton cars which have ever been built. Its cubical capacity and weight were stated in the table on page 354.

As a backbone the GM car has a box girder 14 ins. wide, open at the bottom and built of two pressed steel channels with the flanges facing each other. At the center of the car this girder has a depth of 18 ins. At the hopper doors it begins to taper in a curve toward the bolsters, where the depth, for a straight portion 23 ins. long, is 10 ins. At the body bolsters the center sills are interrupted, the bolsters being continuous across the car.

The bolster construction of this car is worthy of special notice. The bolster is an inverted pressed steel trough, continuous across the car. Below the bolster is a large cross-shaped bottom cover plate taking in the bottom flanges of the bolster and center sills, extending along the bolster to form the upper side bearings and reaching toward the end of the car to secure the short draft sills. Toward the center of the car this cover plate extends under the center sills to a point 18 ins. from the center of the bolster. This construction is shown in the engraving of the draft gear. In later designs the diaphragm construction of bolsters was used and the center sills were made continuous. From the bolsters to the ends of the car the center sills are continued by short sections of pressed plate construction with a sloping top to suit the slant of the floor at the ends of the car. Within these is the draft gear.



CLASS GM STEEL CAR.

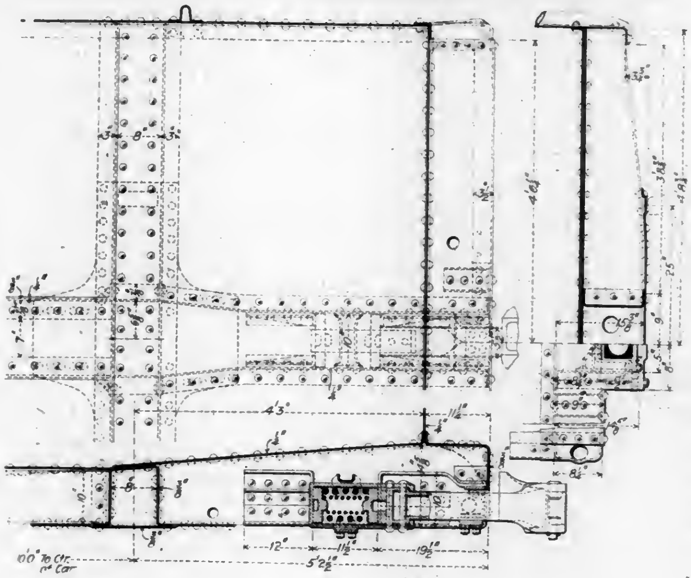
The sides of the car are 7 ft. 2½ ins. high, of ¼-in. plate, stiffened by pressed steel posts riveted to the plate, making panels 3 ft. 6⅝ ins. long. At the top of the sides and ends the side plates have an outward flange of 3¼ ins. to serve as a top chord. Three pressed steel struts of inverted V section tie the side across the car at the top. The floor of this car rests directly on the sills.

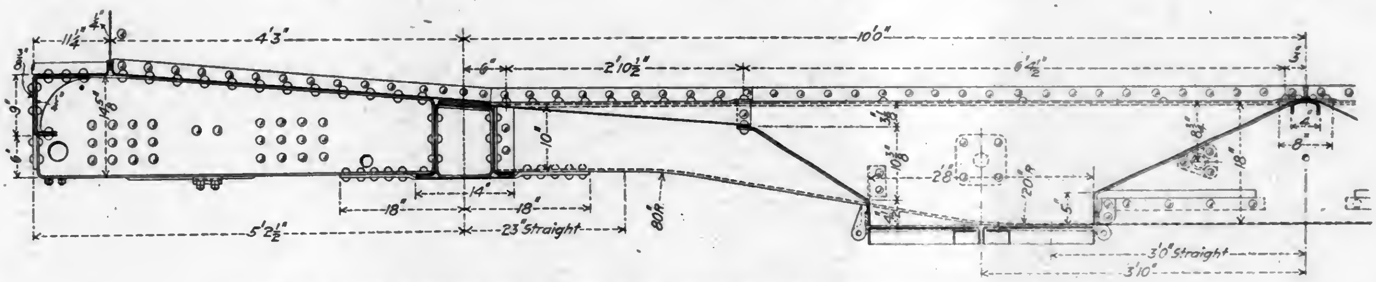
The end sill is a ⅜-in plate of pressed steel, giving a platform 11 ins. wide at each end of the car. This is not cut for the draft gear because of the slope to the floor at the ends of the car. In order to illustrate the interesting end construction

and that of the bolster a detail drawing has been reproduced. This also shows the draft gear which employed a single spring.

The GM cars were mounted on the Vogt trucks, having side frames of the diamond type, of pressed steel.

(To be continued.)





CLASS GM CAR—CENTER SILL, END SILL, BOLSTER AND DRAFT GEAR CONSTRUCTION.

NEW LOCOMOTIVE SHOPS.

READING, PA.

PHILADELPHIA & READING RAILWAY.

VIII.

(Continued From Page 358.)

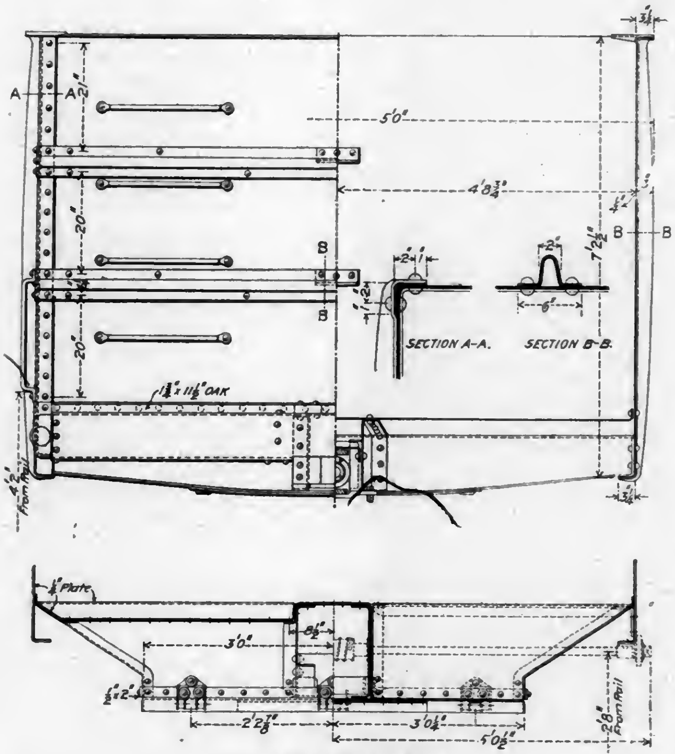
CAPACITY OF THE GENERATING APPARATUS.

An important feature of the problem of designing the electrical equipment for the Reading locomotive shops was that of choosing the total and individual capacities of generator units to be used for the electrical generating equipment of the power plant. The applicability of the method used for determining their capacities, as well as also the successful results in operation of the sizes chosen, reflects very favorably upon those responsible for the design.

The method employed in determining the total generator capacity was that of making a careful estimate of all the power that should be required for the operation of the shops—the result was used as a basis from which to select the total and individual capacities for the generator units to be installed. For accuracy this estimate was divided between the constant load and variable load classes of power consumption. The constant load division included all of the power required for all classes of lighting, both arc and incandescent, and for all motors operating fans, blowers, pressure blowers, pumps and other classes of machinery which have a constant load; due allowance was also made in this estimate for all motor, transformer and line losses. The variable load division included all motors operating machinery and tools which were arranged to work at varying loads.

In providing for the constant load division, generator capacity was, of course, allowed for the full amount expected; but for the variable load, generator capacity was provided for only 33 per cent. of the total capacity of variable-speed motors to be connected up for use. This factor of 33 per cent. was determined upon by Mr. E. E. Brown, the Electrical Engineer in charge of the design, after a very careful investigation of the subject. The operating conditions met in running variable-speed motors at the Baldwin Locomotive Works, Philadelphia, Pa., and at the works of the General Electric Co., at Schenectady, N. Y., of the New York Shipbuilding Co., at Camden, N. J., and of the Westinghouse Air Brake Co., at Wilmerding, Pa., were carefully studied by him, with the result that factor of 33 per cent. was chosen. In the above mentioned shops, the load factor of variable-speed motors varied from 20 to 30 per cent., 23 per cent. being a fair average. Considering the factor of 23 per cent. to be good practice, the factor of 33 per cent., which was chosen, allows a considerable margin for growth.

In the first preliminary work of determining the amount of power to be required in the shops, an interesting method of testing was resorted to in ascertaining the amounts of power to be demanded by the different tools in the machine shop, in order that the estimate of the power to be required in this department might be accurately formed. A 50-h.p. motor, with accurately calibrated Weston measuring instruments, was taken through the old shop for a complete canvass of the



CLASS GM STEEL CAR.

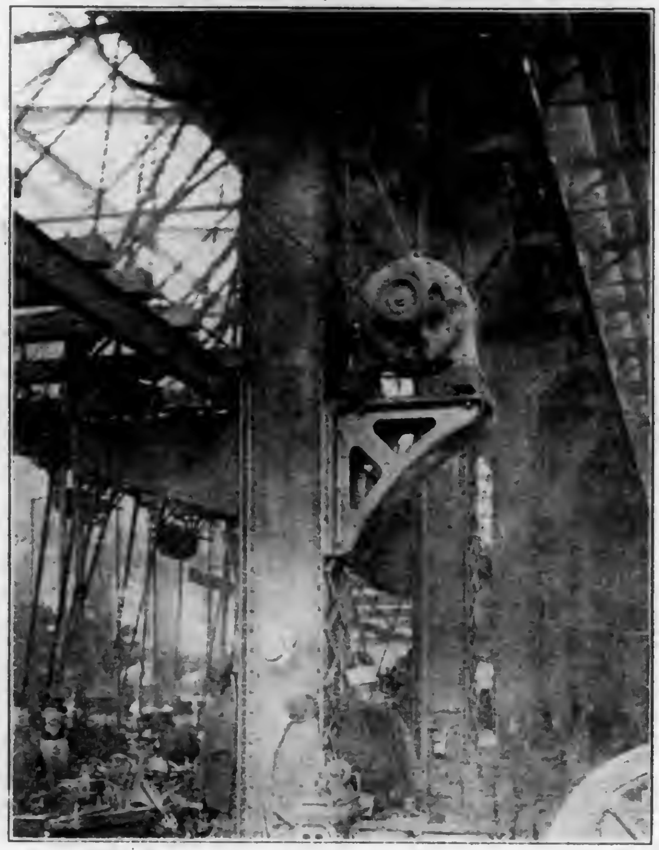
Mr. J. R. Skinner has been appointed assistant superintendent of motive power of the Delaware & Hudson, with headquarters at Oneonta, N. Y., being promoted from the position of division master mechanic at that point.

power required by it to drive every tool large enough for individual driving. Also a test was made of one typical machine tool of each kind and class, without regard to the manner in which it was to be driven, in order to determine the power necessary to operate it, and in cases where numbers of the tools were then grouped together in substantially the same layout as they would be arranged in the new shop plan, the power required to drive them as a unit was determined by group driving. In each test readings were taken of the power required by the motor to operate the machines at average and maximum capacities, and also the power required to drive separately: the line shaft, the tool empty, the tool loaded, and the motor running free, the latter reading being taken after each of the other tests. These tests established a basis which greatly facilitated the accurate determination of the generator capacity to be provided for the machine tool department of the shops.

SIZES OF THE GENERATING UNITS.

As stated in the previous article, in connection with the considerations governing the choosing of the type of generators, it was found after a careful investigation that 150-K.W.

TYPICAL ARRANGEMENT OF MOTOR—WEST SIDE OF MACHINE SHOP BAY.



CLOSE VIEW OF MOTOR—SHOWING BRACKET SUPPORTS—EAST SIDE OF MACHINE SHOP BAY.

TYPICAL GROUP-DRIVE MOTORS. READING SHOPS.—PHILADELPHIA & READING RAILWAY.

would have to be supplied in the form of direct current and 1,050-K.W. in the form of two-phase alternating current. As it was decided to generate the entire amount in the form of the alternating current, the direct current to be supplied by transformation, it was found that the aggregate capacity of the generating apparatus would have to be slightly over 1,200-K.W. (allowing for rotary transformer losses in generating the direct current.)

A careful study of the nature of the service to be called for led to the adoption of three generating units, of 400-K. W. capacity each, for supplying the total of 1200-K. W. alternating, and also it was thought best to provide an additional reserve unit of one-half the size of the larger units, namely—200-K.W., in order to more economically take care of the night and holiday loads. This made a total generating capacity 1400-K.W. which is now available in the power plant, thus furnishing an ample margin for future growth.

The advantages of providing the odd 200-K.W. generating unit are several. Besides being able to more economically supply the night-lighting load for the yards, depots, etc., as well as for any departments of the shop that might be required to operate at night for emergency work, this unit will also be very useful for operation together with the large generators when the total output of the station equals one and one-half, or two and one-half, times the capacity of one of the 400-K.W. units, as in such cases the 200-K.W. unit will take its full share of the load, causing all the units to operate at their maximum efficiency. The 200-K.W. unit can also act as a reserve unit and, in operating with an overload upon itself in conjunction with two of the larger units also overloaded, would enable the station to deliver the total capacity of 1200-K.W., in case of failure of a single one of the larger units.

For supplying the 150-K.W. of direct current required, which was to be transformed by rotary-convertors from the two-phase alternating current, it was found advisable to install two 150-K.W. rotaries, each of which would be capable of carrying the full load. In this way one of the convertors is always in reserve for immediate use in case of failure of the other, and, furthermore, in case of any possible abnormal demand for direct current above 150-K.W., both rotaries may be operated in parallel and supply any demand up to 300-K.W. over. This makes a very flexible and desirable arrangement for the direct-current supply.

METHOD OF DRIVING THE TOOLS.

The considerations which led up to the adoption of group driving for the operation of the greater number of the machine tools are particuladly important in view of the great interest that is, at present, being taken in the question of power distribution in machine shops. Owing to the nature of the locomotive repair work, as it had been carried out at the Reading shops, the tools in the machine shop were what might, in general, be classed as light tools, and for this class of tools it was considered that only in special cases could any advantage be gained from individual motor driving. The individual driving system, although having many advantages, offered the disadvantages of introducing a large number of motors to require attention and repairs, high first-cost, and necessarily lower efficiency of power-transmission than the larger motors that would be used for group driving.

There were found cases where the advantages of individual driving would more than offset the above-mentioned disadvantages, each of which required to be separately considered by itself. But in this installation the following factors weighed

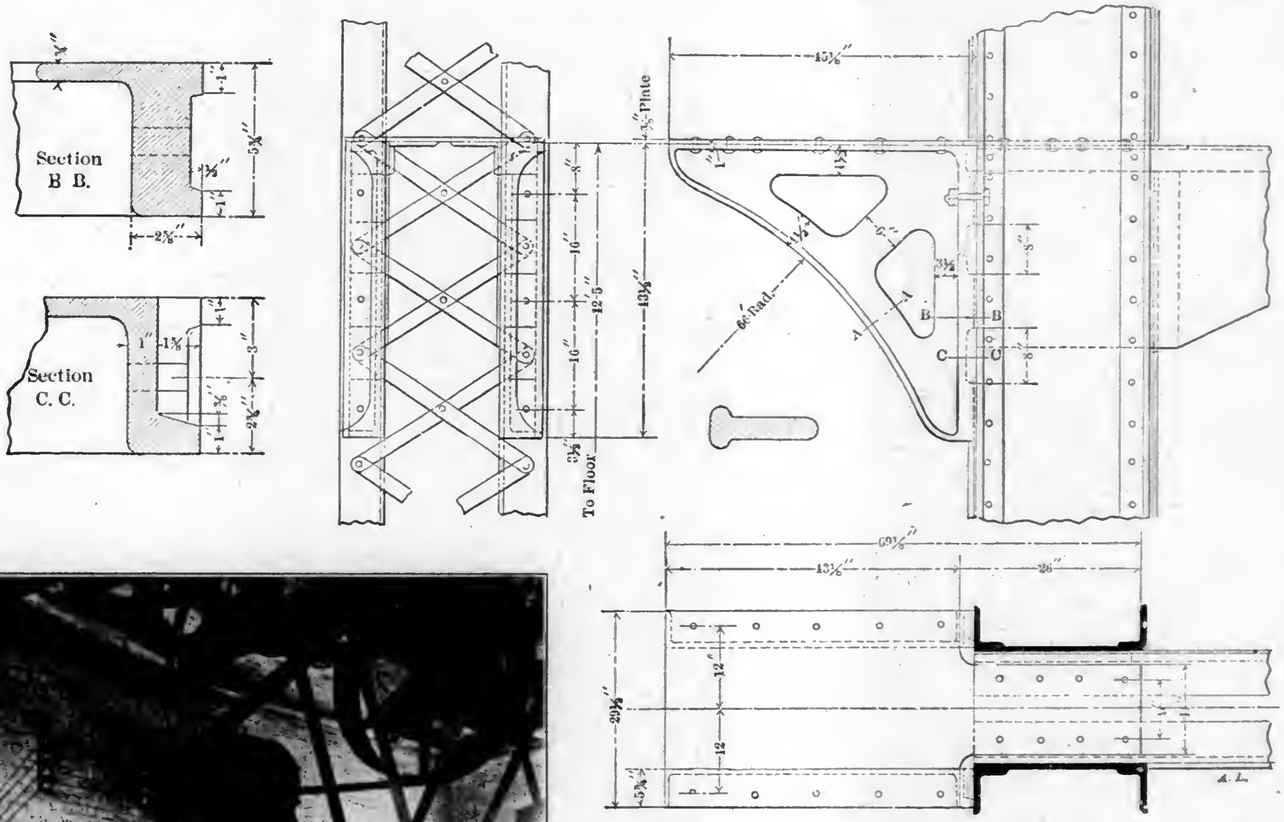
against the adoption of indiviual motor-driving for all the machine tools in the shops:

(a.) The tools were comparatively small in size and each was run almost constantly upon one class of work;

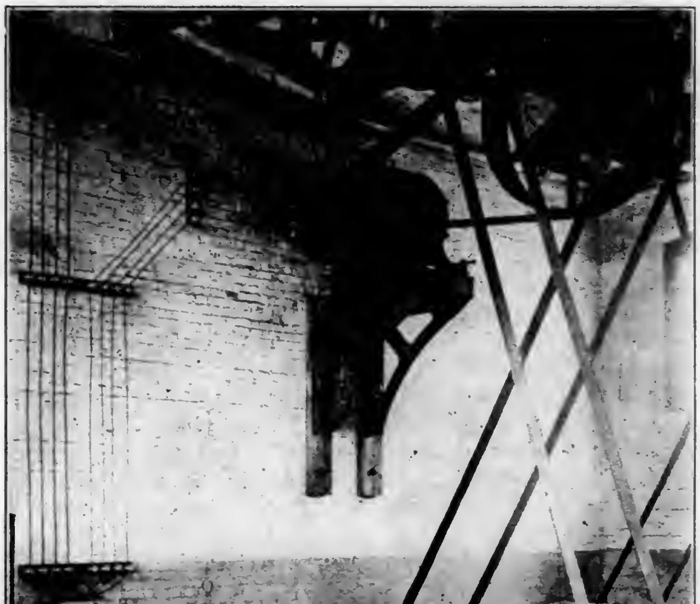
(b.) The cost of power is very low as a low-grade of coal is used which is obtained from mines owned by the railroad company.

(c.) No additional strength would be required in the structural iron work to which the line shaft would be secured, as the columns must necessarily be very heavy on account of supporting the locomotive crane runways, so that an excess strength would be provided.

(d.) In most cases the tools were already supplied with



DETAILS OF THE STANDARD CAST-IRON MOTOR BRACKET USED UPON WALLS AND POSTS FOR SUPPORTING GROUP MOTORS.



VIEW OF GROUP MOTOR AND WIRING TO STARTING SWITCH, SHOWING USE OF STANDARD MOTOR BRACKET—RATTLER GROUP IN FOUNDRY.

countershafts, belts and shifting rigging, so that the adoption of individual driving would mean a loss in this direction.

(e.) In case individual driving were used, the exposed positions of the variable-speed, direct-current motors, that would have to be used, would practically require the use of a distribution voltage not higher than 220 to 250 volts, in order to avoid motor and wiring troubles; whereas, with group driving, the motors and wiring can be placed at a considerable height above the floor, and furthermore, the alternating current (constant-speed) induction motor can be used—a motor of the most simple construction, having no sliding contacts and no wearing parts, except the bearings, and which requires much less attention than the direct-current motor; the induction motor also permits a distribution voltage of from 400 to 500 volts, with freedom from motor or wiring troubles.

A careful consideration of the foregoing factors led to the adoption of the group-drive method of operating the greater part of the machine tools in the machine shop. In this particular instance it is interesting to note that, with the induction motors using no compensators and operating with the distribution voltage of 480 volts, the saving in starting boxes, wiring and number of spare parts to be kept in reserve, as compared with direct-current motor and distribution at 250 volts, fully compensated for the increased first cost of the alternating current apparatus, not to seak of giving a much simpler system.

GROUP DRIVING.

The accompanying engravings illustrate typical arrangements of group driving motors, and their bracket supports, as they have been installed for operating machinery in the shop buildings. The motors used for this purpose are the two-phase induction motors (constant-speed), all of which were furnished by the General Electric Company, Schenectady, N. Y.

The first two engravings illustrate group motors operating tools in the machine shop. In this department, the motors are mounted upon standard brackets fastened to the crane columns, from which they drive by belts the line shafting located further up on the columns. Then, as may be seen in the views, the countershafts for the machine tools are carried upon framework supported upon long plate-steel brackets, set on the opposite side of the columns from the motor-support brackets, from which position they are driven from the line shaft with facility. In this way all shafting and belting is concentrated along the lines of crane columns separating the machine shop bay from the two outside erecting shop bays, and thus the crane service is not interfered with except directly beneath the overhanging countershafting framework in the machine shop bay.

The main line shaft hangers are supported upon wooden

power required by it to drive every tool large enough for individual driving. Also a test was made of one typical machine tool of each kind and class, without regard to the manner in which it was to be driven, in order to determine the power necessary to operate it, and in cases where numbers of the tools were then grouped together in substantially the same layout as they would be arranged in the new shop plan, the power required to drive them as a unit was determined by group driving. In each test readings were taken of the power required by the motor to operate the machines at average and maximum capacities, and also the power required to drive separately, the line shaft, the tool empty, the tool loaded, and the motor running free, the latter reading being taken after each of the other tests. These tests established a basis which greatly facilitated the accurate determination of the generator capacity to be provided for the machine tool department of the shops.

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A careful study of the nature of the service to be called for led to the adoption of three generating units, of 400-K. W. capacity each, for supplying the total of 1200-K. W. alternating, and also it was thought best to provide an additional reserve unit of one-half the size of the larger units, namely—200-K.W., in order to more economically take care of the night and holiday loads. This made a total generating capacity 1400-K.W. which is now available in the power plant, thus furnishing an ample margin for future growth.

The advantages of providing the odd 200-K.W. generating unit are several. Besides being able to more economically supply the night-lighting load for the yards, depots, etc., as well as for any departments of the shop that might be required to operate at night for emergency work, this unit will also be very useful for operation together with the large generators when the total output of the station equals one and one-half, or two and one-half, times the capacity of one of the 400-K.W. units, as in such cases the 200-K.W. unit will take its full share of the load, causing all the units to operate at their maximum efficiency. The 200-K.W. unit can also act as a reserve unit and, in operating with an overload upon itself in conjunction with two of the larger units also overloaded, would enable the station to deliver the total capacity of 1200-K.W., in case of failure of a single one of the larger units.

For supplying the 150-K.W. of direct current required, which was to be transformed by rotary-convertors from the two-phase alternating current, it was found advisable to install two 150-K.W. rotaries, each of which would be capable of carrying the full load. In this way one of the convertors is always in reserve for immediate use in case of failure of the other, and, furthermore, in case of any possible abnormal demand for direct current above 150-K.W., both rotaries may be operated in parallel and supply any demand up to 300-K.W. over. This makes a very flexible and desirable arrangement for the direct-current supply.

TYPICAL ARRANGEMENT OF MOTORS—WEST SIDE OF MACHINE SHOP BAY

CLOSE VIEW OF MOTOR SHOWING BRACKET SUPPORTS—EAST SIDE OF MACHINE SHOP BAY

TYPICAL GROUP DRIVE MOTORS. READING SHOPS.—PHILADELPHIA & READING RAILWAY

METHOD OF DRIVING THE TOOLS.

The considerations which led up to the adoption of group driving for the operation of the greater number of the machine tools are particuladly important in view of the great interest that is, at present, being taken in the question of power distribution in machine shops. Owing to the nature of the locomotive repair work, as it had been carried out at the Reading shops, the tools in the machine shop were what might, in general, be classed as light tools, and for this class of tools it was considered that only in special cases could any advantage be gained from individual motor driving. The individual driving system, although having many advantages, offered the disadvantages of introducing a large number of motors to require attention and repairs, high first-cost, and necessarily lower efficiency of power-transmission than the larger motors that would be used for group driving.

There were found cases where the advantages of individual driving would more than offset the above-mentioned disadvantages, each of which required to be separately considered by itself. But in this installation the following factors weighed

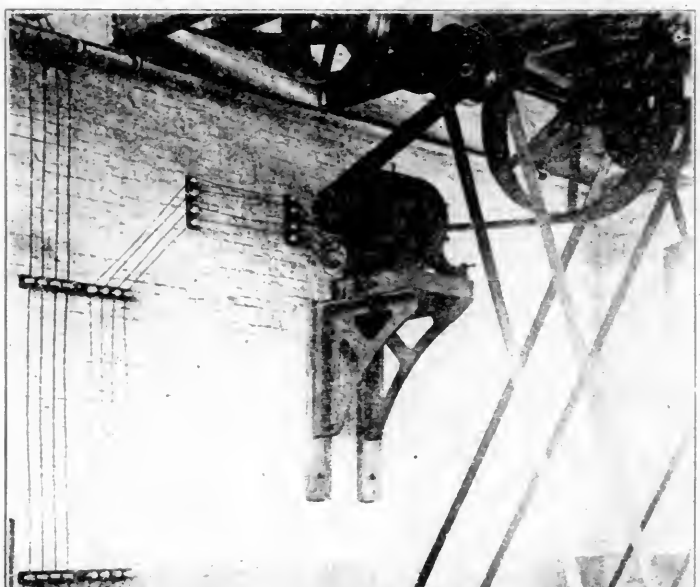
against the adoption of indivinal motor-driving for all the machine tools in the shops:

(a.) The tools were comparatively small in size and each was run almost constantly upon one class of work;

(b.) The cost of power is very low as a low-grade of coal is used which is obtained from mines owned by the railroad company.

(c.) No additional strength would be required in the structural iron work to which the line shaft would be secured, as the columns must necessarily be very heavy on account of supporting the locomotive crane runways, so that an excess strength would be provided.

(d.) In most cases the tools were already supplied with

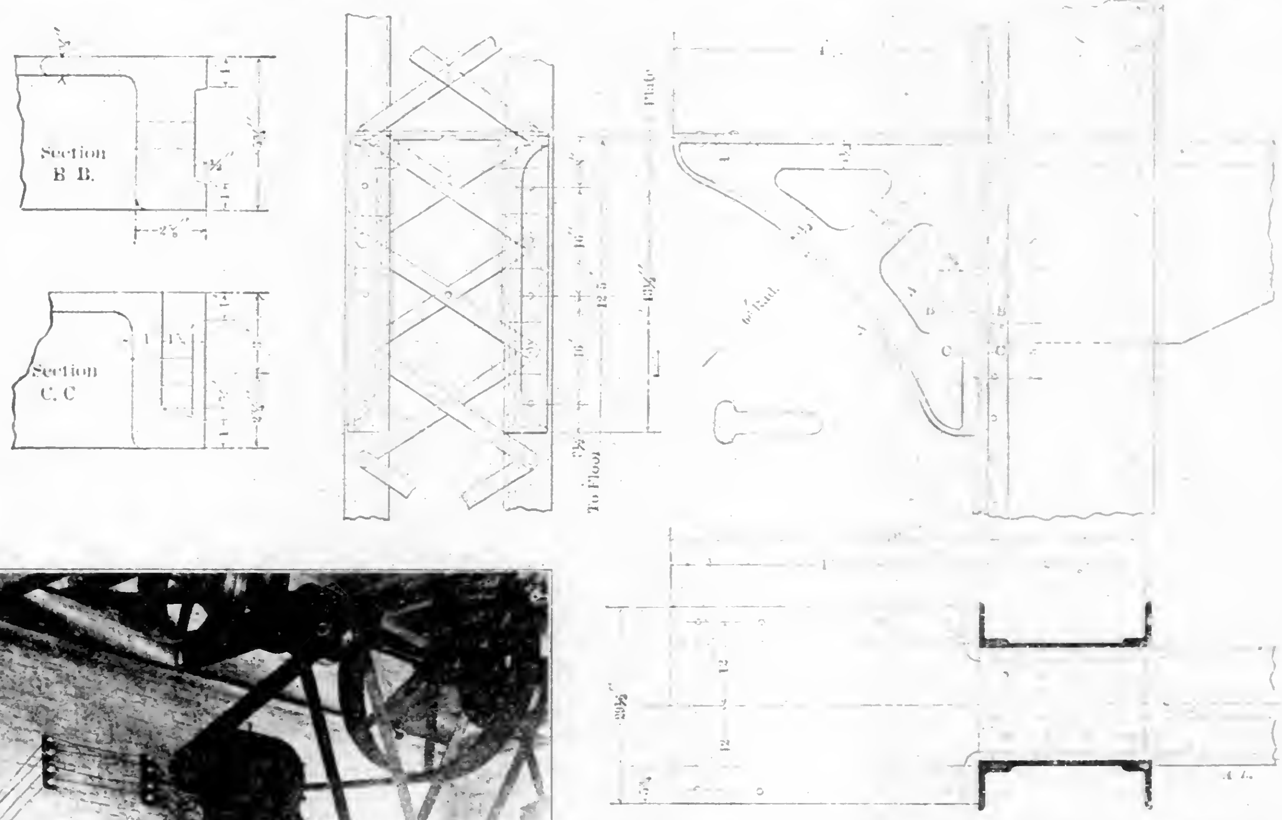


VIEW OF GROUP MOTOR AND WIRING TO STARTING SWITCH, SHOWING USE OF STANDARD MOTOR BRACKET—RATTLER GROUP IN FOUNDRY.

countershafts, belts and shifting rigging, so that the adoption of individual driving would mean a loss in this direction.

(e.) In case individual driving were used, the exposed positions of the variable-speed, direct-current motors, that would have to be used, would practically require the use of a distribution voltage not higher than 220 to 250 volts, in order to avoid motor and wiring troubles; whereas, with group driving, the motors and wiring can be placed at a considerable height above the floor, and furthermore, the alternating current (constant-speed) induction motor can be used—a motor of the most simple construction, having no sliding contacts and no wearing parts, except the bearings, and which requires much less attention than the direct-current motor; the induction motor also permits a distribution voltage of from 400 to 500 volts, with freedom from motor or wiring troubles.

A careful consideration of the foregoing factors led to the adoption of the group-drive method of operating the greater part of the machine tools in the machine shop. In this particular instance it is interesting to note that, with the induction motors using no compensators and operating with the distribution voltage of 480 volts, the saving in starting boxes, wir-



DETAILS OF THE STANDARD CAST-IRON MOTOR BRACKET USED UPON WALLS AND POSTS FOR SUPPORTING GROUP MOTORS.

ing and number of spare parts to be kept in reserve, as compared with direct-current motor and distribution at 250 volts, fully compensated for the increased first cost of the alternating current apparatus, not to seak of giving a much simpler system.

GROUP DRIVING.

The accompanying engravings illustrate typical arrangements of group driving motors, and their bracket supports, as they have been installed for operating machinery in the shop buildings. The motors used for this purpose are the two-phase induction motors (constant speed), all of which were furnished by the General Electric Company, Schenectady, N. Y.

The first two engravings illustrate group motors operating tools in the machine shop. In this department, the motors are mounted upon standard brackets fastened to the crane columns, from which they drive by belts the line shafting located further up on the columns. Then, as may be seen in the views, the countershafts for the machine tools are carried upon framework supported upon long plate-steel brackets, set on the opposite side of the columns from the motor-support brackets, from which position they are driven from the line shaft with facility. In this way all shafting and belting is concentrated along the lines of crane columns separating the machine shop bay from the two outside erecting shop bays, and thus the crane service is not interfered with except directly beneath the overhanging countershafting framework in the machine shop bay.

The main line shaft hangers are supported upon wooden

strips bolted to the lower sides of the crane runways, which places this stafting up entirely out of the way. The line shaft pulleys which the motors drive are in all cases 60 ins. in diameter, any adjustment of line shaft speed in relation to the motor speed being made by changing the motor's pulley. The line shafting is practically continuous along the length of the shop, but is easily broken up into groups as there are shaft couplings at each crane column; in this way if one group motor becomes overloaded, a section of its line shaft may be uncoupled from it and coupled onto the group next to it on either side. The effort has been to locate the group motors as near as possible to the centers of their distribution of driving. The largest group drive embraces 180 ft. of line shaft.

The countershafting framework is built up of I-beams supported upon the plate brackets projecting into the machine bay as shown. The details of attachment to the columns, as well as the details of the standard cast-iron motor bracket are shown in the drawings reproduced. Where motor and countershaft brackets are located on opposite sides of the same column, additional strength is given them by tying together by through plates on top. In all the hangers for shafting the Hyatt roller bearings are used which reduces the friction to a minimum; in fact, the shafting can easily be turned by hand.

We are greatly indebted to Mr. E. E. Brown, electrical engineer for the Philadelphia & Reading Ry., for this interesting information.

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

Apprenticeship continues to be an interesting subject among motive power men. Whether or not the editorial treatment of the subject in this journal has increased the interest in it is not important, but something has evidently set people to thinking about it.

One superintendent of motive power expressed the opinion that courses of apprenticeship for college men are wrong in principle and ineffective. He has decided to offer college graduates places as helpers in the roundhouse instead of starting them in the shop. He reasons that they should not consider the railroad work as a school in any sense, but that they should be placed at once where they become a part of the organization and where they can do work for which their training fits them. Furthermore, he would have them take the hardest and most distasteful work first. The roundhouse he considers the weakest part of the motive power organization. It is also one of the most important parts and one which cannot be understood by observation. To a greater extent shop practice has been reduced to routine and its principles may be obtained by observation combined with experience. A good roundhouse man is often a good shop man, but it is not so often that a good shop man is good in the roundhouse, where every hour has its emergency and where very little system can be employed. The roundhouse offers many opportunities for intelligence, and it is here that a thoughtful, earnest young man can best obtain experience and gain confidence as well as show his capabilities. This officer has tried this plan and his roundhouse foremen say that they cannot do without these young men when they have once had them. In connection with the roundhouse the boys naturally find themselves fitting into places of real importance in times of business stress. They study failures and learn to appreciate the meaning of the forces with which they must deal. At the roundhouse they get a view of the relations between the locomotive and the operating department. On this road the college men are paid the wages of helpers and are engaged exactly as other helpers are engaged. They have no privileges and no promises, but are naturally employed from time to time in special investigations and tests. In this work they are given responsible charge and are assisted by the regular shop apprentices. This is done in order to encourage the regulars to study and to become ambitious to make the best use of their opportunities. The college boys are given to understand that they are put where they will be of the most value to their employers and that they must be promoted, if at all, because of their value and their ability to take up more important work. This officer does not consider shop experience unnecessary; he would have the boys spend time in the shops, but not until after they have considerable knowledge and experience with the locomotive. His views are printed without comment. These opinions must be considered significant of a careful study of the apprentice problem and there can be no more important subject before railroad men.

Discussion of labor troubles is usually approached in hushed tones and with furtive glances. That there is good reason for this must be apparent to anyone who talks with any employer of men, and particularly one who sounds the views of a large number of railroad officials. The labor problem on railroads is particularly difficult, and is likely to become very much more so. Without assuming to offer any more or less wise solution, a note of warning can and should be sounded where it will be heard. The labor problem is one requiring the utmost knowledge of men, complete understanding of their work and its conditions and their environment; positive information as to what may be properly expected of them, combined with consummate tact and upright dealing. The warning needed is against a flippant and shallow view of the situation. Those who appreciate the labor problem have no difficulty with it. The flippant view is exhibited by officers who boast of their victories—and there are many who do this—and also sometimes by managements and highest executive officers. The latter have shown it to our representative by an apparent disregard of the fundamental necessity of establishing a definite and logical policy with reference to the management of their subordinates. To build up a satisfactory condition of a large number of employees requires time and confidence born of a long period of just and fair treatment, yet we find a railroad president calmly discussing radical changes in administration and personnel which, if enacted, will upset the labor of years and create a state of unrest and uncertainty which will easily lead to disturbances. A well-balanced, confidence-inspiring and broad-minded policy for dealing with men was never so greatly needed as it is now. For the proper treatment of this matter experienced, clear-headed and able officers are needed, men who have studied the past and understand the tendencies enough to know what can be done and what cannot be done with labor. Railroads need a warning because they are not sufficiently careful to consider these things in their preparation of young men for important positions and in their estimate of the value of older men who have served faithfully and long.

An immense artificial cascade has been determined upon by the authorities of the Louisiana Purchase Exposition as the centerpiece of the semi-circular lay-out of the principal buildings. The cascade itself will be divided into three parts: a large, middle cascade with a smaller one at each side, the water flowing directly into the head of the grand basin. In all, about 90,000 gals. of water per minute will be supplied at a head of 159 ft., forming the greatest artificial water effect ever attempted. The water will be taken from the grand basin itself and will be raised to the top of the cascade by a pumping station located under festival hall. The pumping machinery will consist of three 36-in. single-stage turbine centrifugal pumps, purchased from Henry R. Worthington, of New York City, each driven by a 2,000-h.p. Westinghouse alternating current motor. The total horse-power utilized will thus be 6,000, making this the largest electric pumping station in the world. The pumps and other pieces of machinery for this plant are now being installed at St. Louis.

Mr. Herbert F. Moore, mechanical engineer, has resigned as instructor in machine design at Cornell University to accept a position as mechanical engineer at Riehle Bros. Testing Machine Company, 1424 North Ninth street, Philadelphia.

Mr. Stephen F. Sullivan, sales agent for the Ewald Iron Company at Chicago, has been appointed general sales agent for that company, with headquarters in that city.

NEW STEEL CARS ON THE BURLINGTON.

100,000 LBS. CAPACITY.

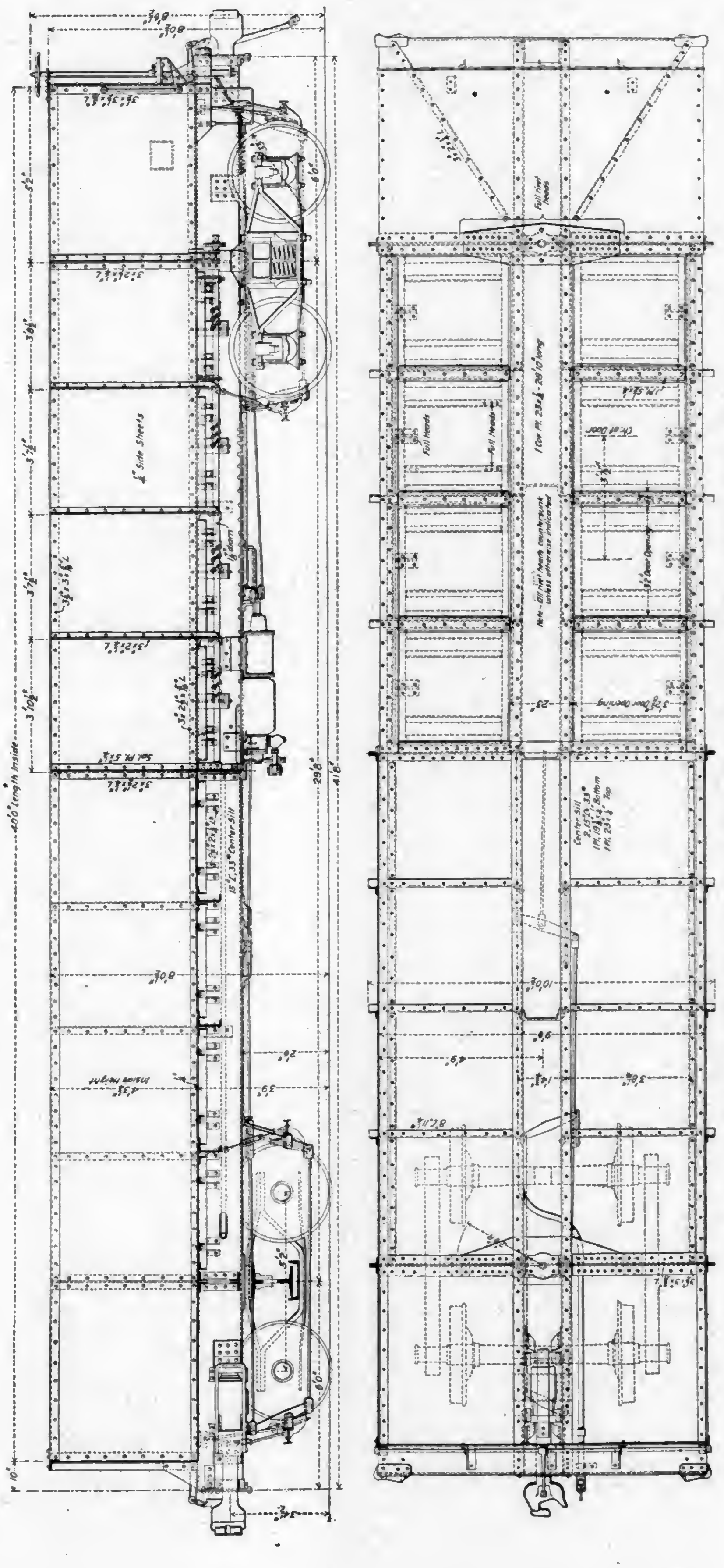
The first order of steel cars for this system is now being built by the Cambria Steel Company for the Chicago, Burlington & Quincy, and the number is to be 1,000. The following table presents the leading dimensions:

Capacity	100,000 lbs.
Length over end sills	41 ft. 8 ins.
Length inside	40 ft.
Width over all	10 ft. ½ in.
Width inside	9 ft. 6 ins.
Height of box, inside	4 ft. 3¼ ins.
Height over sides	8 ft. ½ in.
Height over staff	8 ft. 6½ ins.
Distance, truck centers	29 ft. 8 ins.
Wheel base, trucks	5 ft. 2 ins.
Cubical capacity	1,615 sq. ft.

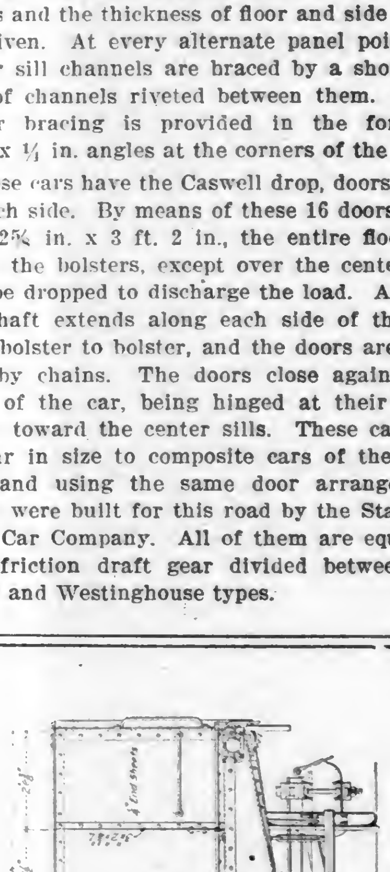
These cars have no side sills, the sides being stiffened, in 3 ft. 10½ in. panels, with angles and surmounted by coping angles. The center-sills are 15 in., 33 lb. channels, which are continuous from end to end and these receive the draft attachments. With cover-plates, top and bottom, the center sills form a box girder as far as the bolsters. Opposite all the panel points in the sides, cross bearers of 8 in. 11¼ lb. channels pass across under the floor from the sides to the center sills, to which they are secured by angle connections.

The bolsters are built up of riveted plate construction with cover plates reaching to the side bearings. In the engravings the sizes of all the angles and the thickness of floor and side plates are given. At every alternate panel point the center sill channels are braced by a short section of channels riveted between them. Light corner bracing is provided in the form of 3 x 2 x ¼ in. angles at the corners of the car.

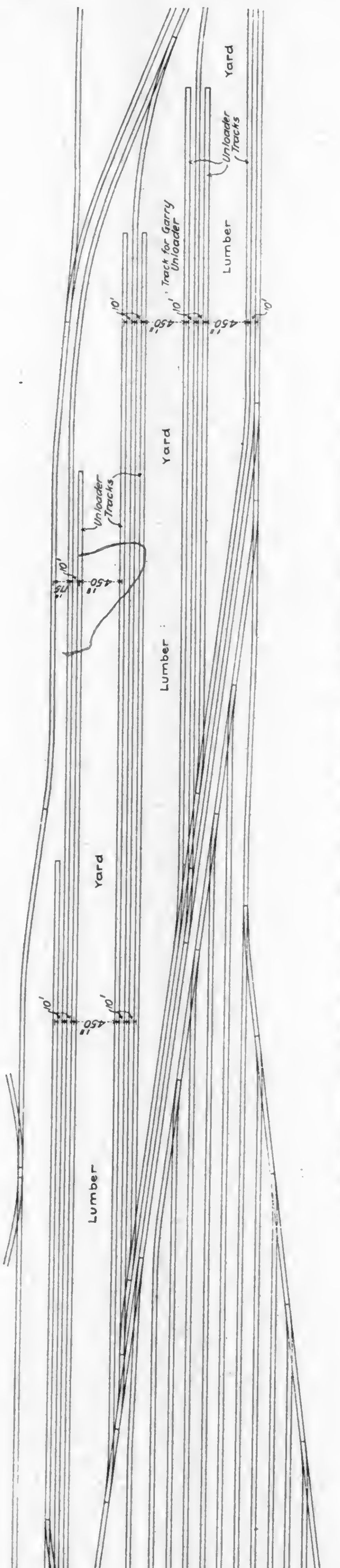
These cars have the Caswell drop, doors, eight on each side. By means of these 16 doors, each 3 ft. 2⅝ in. x 3 ft. 2 in., the entire floor, between the bolsters, except over the center sill, may be dropped to discharge the load. A winding shaft extends along each side of the car, from bolster to bolster, and the doors are operated by chains. The doors close against the sides of the car, being hinged at their inner edges, toward the center sills. These cars are similar in size to composite cars of the same type and using the same door arrangement, which were built for this road by the Standard Steel Car Company. All of them are equipped with friction draft gear divided between the Miner and Westinghouse types.



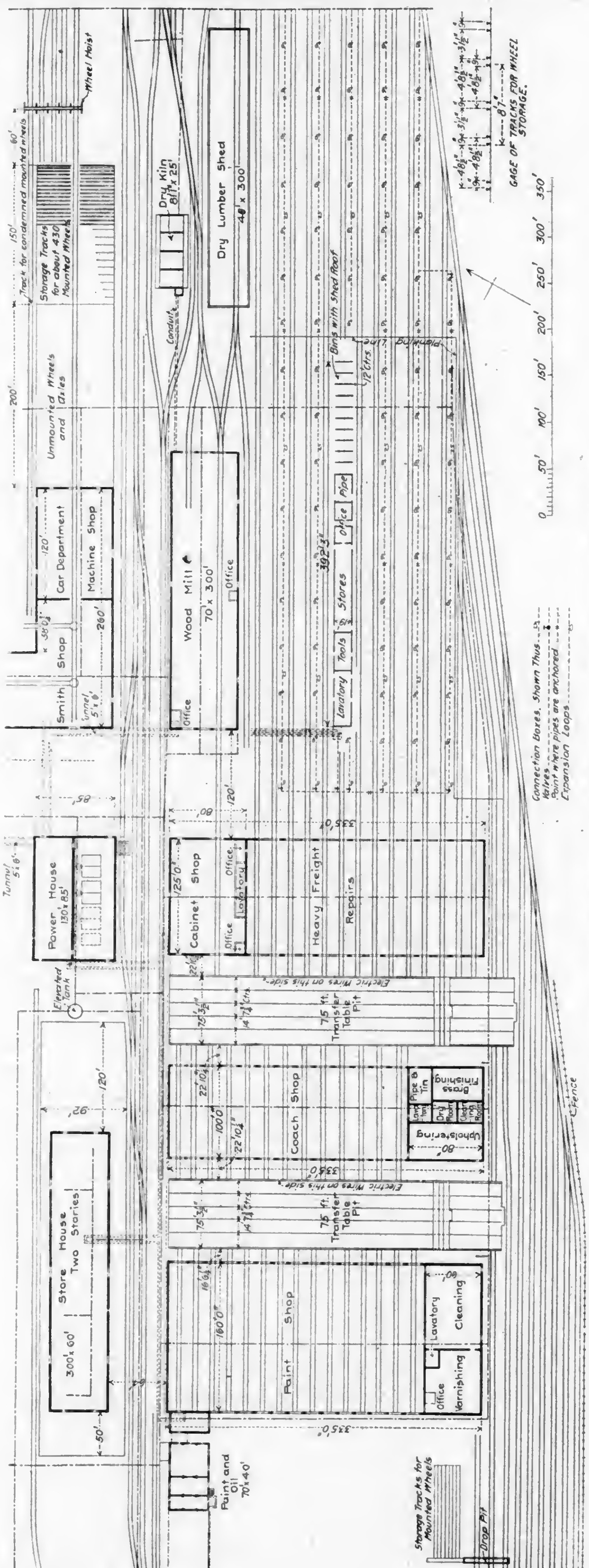
STEEL CARS FOR THE BURLINGTON 100,000 LB. GONDOLAS WITH CASWELL DROP DOORS.



END ELEVATION.

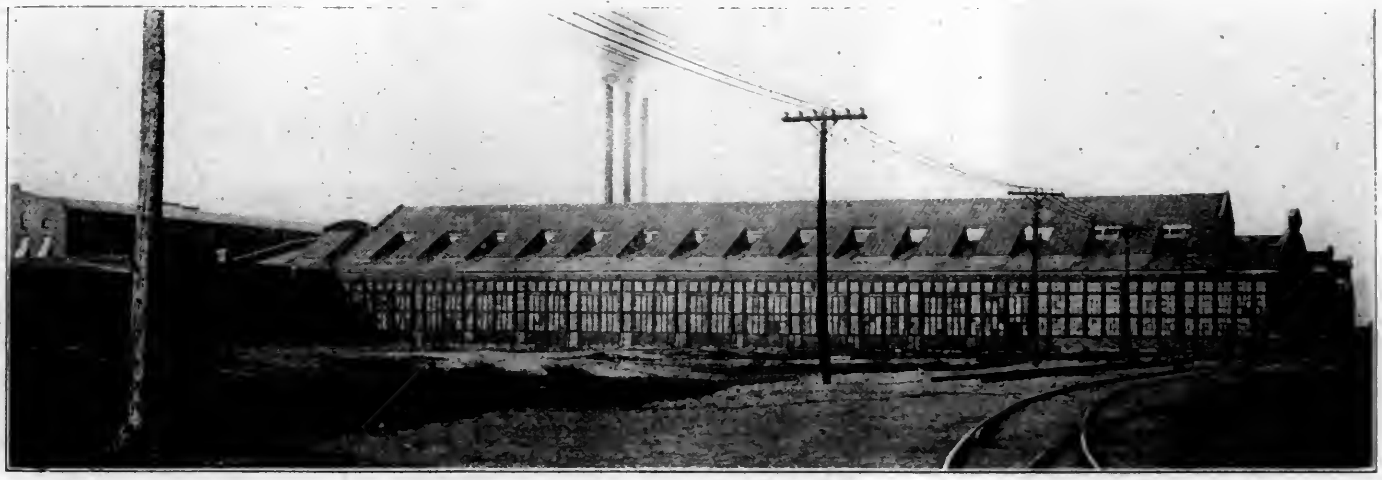


CONTINUATION OF YARD PLAN, SHOWING TRACK CONNECTIONS AND UNLOADER TRACKS IN LUMBER YARD.



COLLINWOOD CAR SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

SHOWING BUILDINGS, YARD AND TRACKS.



PAINT SHOP LOOKING NORTH AND SHOWING ENDS OF THE OTHER LARGE BUILDINGS.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

XII.

GENERAL PLAN OF THE CAR SHOPS AND YARD.

These car shops are specially interesting for their convenience and complete appointments rather than for size, yet they are not small in size as they will maintain all of the passenger equipment cars of the Lake Shore proper, and a large proportion of freight equipment, including steel cars. According to Mr. George N. Dow, master car builder, in charge at Collinwood, the shops will at once turn out 60 coaches per month. These will include varnishing and the annual overhauling of from 50 to 55 cars per month, and complete repairs to from 5 to 10 cars. When running at full capacity the output will be from 75 to 90 cars per month, or 540 cars in nine months. When new equipment is needed 6 or 8 baggage cars may be built per month, and from 15 to 20 cabooses. Cabooses will come in once in two years for general repairs and from 15 to 20 will be handled per month. Four steel cars per day will be the capacity for that equipment at present, and of ordinary freight cars 69 are now handled per day. This capacity will soon be increased to 100 per day. For all of this work 480 men are now employed, and the ultimate capacity of the plant will require about 550. Besides the general repairs, all wheel work at Collinwood, except on driving wheels, will be done in the car shops, the capacity being 500 pairs of wheels per month. The locomotive woodwork and painting is also handled by the car department. In the paint shop 60 coaches will be turned out per month, with a capacity of thirty on the paint-shop tracks. For repairing steel cars 9 cars will be provided for in the shop, and light repairs will be made on the outside tracks.

A remarkable record was made in moving into these shops from the old plant in Cleveland. The old plant was closed Saturday, August 29, and the new shops opened at 7 A. M. on Monday, August, 31. A train of 16 coaches carried the tools of the men, and the last of the material was loaded on 87 cars in the two days prior to the closing of the old shop. The entire transfer constituted 423 carloads, of which 365 cars were loaded in five days by the men of this department, under the energetic direction of Mr. Dow.

On page 304 of our October number of last year a table of areas and other comparative dimensions of the car shops was given, but as these figures have been somewhat changed as the work progressed, a revised statement is now necessary. The plan of tracks and the smaller buildings have also been changed in some respects, which necessitates the presentation of the ground plan in revised form. In accordance with the purpose of presenting this plant accurately, the car-shop plans are brought down to date in the accompanying engravings.

FLOOR AREAS OF CAR SHOP BUILDINGS.

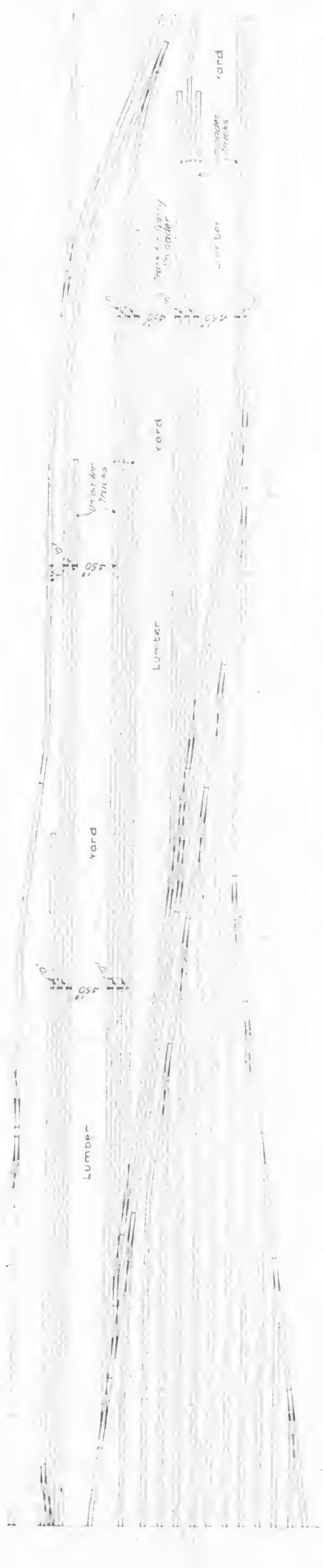
	Sq. Ft.
Passenger coach repair shop (335 x 100)	33,500
Passenger coach paint shop (335 x 160)	53,600
Cabinet shop (125 x 80)	10,000
Total passenger coach shop	97,100
Freight car repair shop (255 x 125)	31,875
Wood mill (300 x 70)	21,000
Car department machine shop (120 x 80)	9,600
Paint and oil storage (70 x 40)	2,800
Upholstery, pipe and tin, cleaning and drying and brass furnishing (100 x 80)	8,000
Varnishing and cleaning (160 x 60)	9,600
Percentages of total passenger shops	97,100
Passenger paint shop	55.2%
Passenger repair shop	34.5%
Cabinet shop	10.3%
	100.0%
Upholstery, pipe, tin, cleaning, drying and brass finishing section in per cent. of total passenger shop	23.9%
Varnishing and cleaning sections in per cent. of total passenger coach paint shop	17.9%

DISTANCES OF TRAVEL BETWEEN CENTERS OF SHOP DEPARTMENTS.

Passenger coach repair shop to cabinet shop	=	320 ft.
Passenger coach repair shop to wood mill	=	650 ft.
Passenger coach repair shop to car machine shop	=	840 ft.
Passenger coach repair shop to blacksmith shop	=	740 ft.
Passenger coach repair shop to mounted wheel storage	=	1,175 ft.
Passenger coach repair shop to storehouse	=	395 ft.
Passenger coach repair shop to paint shop	=	240 ft.
Freight car repair shop to wood mill	=	500 ft.
Freight car repair shop to cabinet shop	=	170 ft.
Freight car repair shop to car machine shop	=	690 ft.
Freight car repair shop to blacksmith shop	=	590 ft.
Freight car repair shop to mounted wheel storage	=	1,025 ft.
Freight car repair shop to storehouse	=	710 ft.
Freight car repair shop to freight repair stores	=	405 ft.
Freight car repair shop to paint and oil storage	=	810 ft.
Wood mill to passenger coach repair shop	=	650 ft.
Wood mill to cabinet shop	=	335 ft.
Wood mill to freight car repair shop	=	500 ft.
Wood mill to dry kiln	=	400 ft.
Wood mill to dry lumber shed	=	480 ft.

In the plan the location of the car-department machine shop at the end of the blacksmith shop will be noted. This places the machine, as well as blacksmith work for the car-repair yards, as well as the car-shop buildings, within easy communication with all of the work.

The passenger-car paint shop is exclusively for the use of painters, and no repair work whatever is to be done here. This rule is not everywhere followed, but it should be observed, in order to avoid dust in the shop. The intended capacity, when worked at its limit, will be 75 per month. The drying of paint and varnish will be accelerated by the fan system of ventilation and heating. In order to return the air to the heating system from the entire shop, the return-ducts are placed under the floor, and the openings are covered by registers. The heating system is guaranteed to heat the building to 60 degs. in zero weather. There are 15 tracks, long enough for two cars each. The floor is of concrete on cinders and topped with a special composition made by the Granitoid Company of Cincinnati for the prevention of abrasion and the raising of dust. A slope of 3 ins. between tracks is provided, and a gutter with a grating runs the full length of the tracks to catch the water dripping from the cars in cleaning. For holding the sash and



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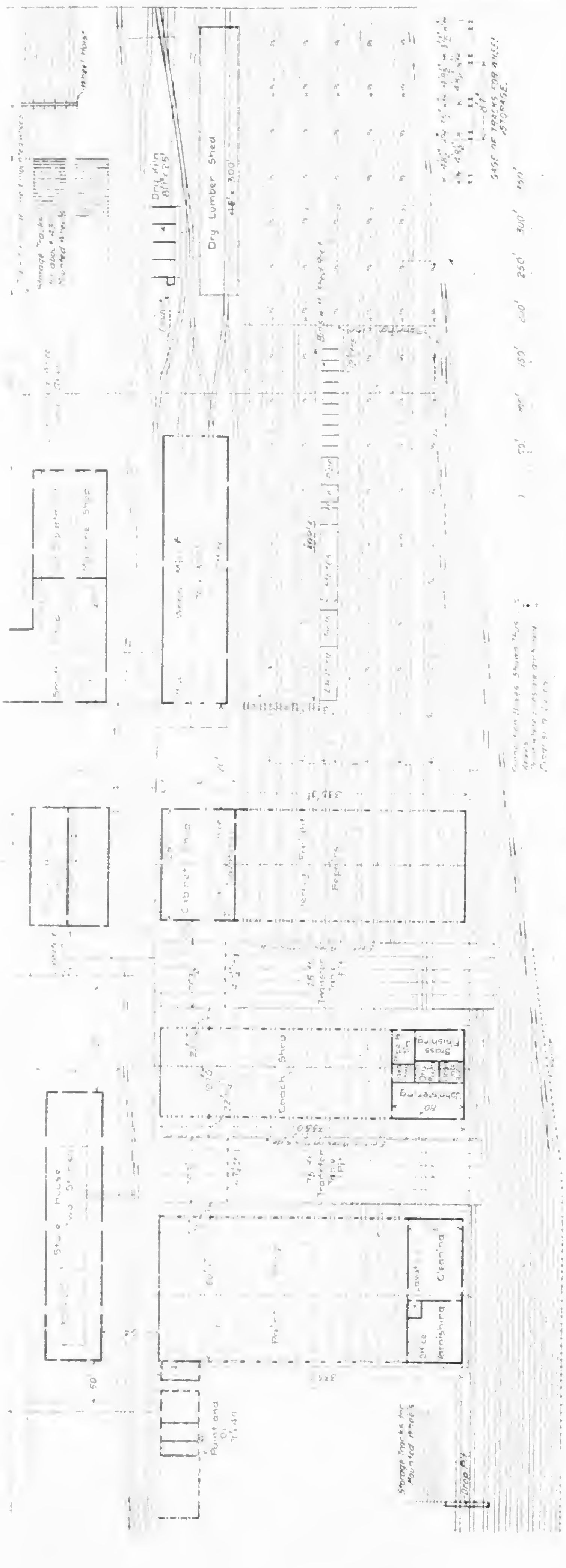

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Passenger coach repair shop to storehouse	= 395 ft.
Passenger coach repair shop to paint shop	= 240 ft.
Freight car repair shop to wood mill	= 500 ft.
Freight car repair shop to cabinet shop	= 170 ft.
Freight car repair shop to car machine shop	= 690 ft.
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blinds special racks have been designed. These and other details, such as the post tubs for use in washing cars, will be illustrated later. The car-shop buildings are fitted with incandescent lamps between the tracks and arc lamps over the tracks. The daylight lighting is unusually good, as will appear in the description of the construction of the buildings next month. This part of the design of the buildings has received an unusual amount of careful attention.

At the north end of the freight-car repair shop a space is reserved for the cabinet shop, and it is understood that these spaces in the ends of these buildings may be used later for extensions, and the small departments provided for elsewhere, when the space may be required. Each track in this shop holds three cars. Three shop tracks will be used for steel cars and the remainder for heavy repairs to wooden cars. At the south end three tracks will be used for caboose cars.

The air and steam hose for all cars on the Lake Shore road is supplied from the Collinwood storehouse, and it is all fitted up and tested at this plant. In the material supply building in the freight repair yard the triple valve testing eqiupment has been installed and the fitting up of air and steam hose is done here.

In the passenger repair shop each track provides for a single car only. At the north end three tracks are used for truck work only, and these are provided with cranes and air hoists for handling steel trucks. The remainder of the shop is occupied with heavy repairs, and at the south end 15 cabooses are now in process of building. For testing purposes this shop is fitted with steam, water and air connections, and all cars will be thoroughly tested in all three ways. The steam-heater pipes, air-brake system and water-raising equipment are tested on the cars before they leave this building.

In the freight-car repair yard the repairers' shed is conveniently located, and for the convenience of the men the entire yard is piped for air, with connection boxes located as indicated in the plan. All of the piping, including the heating system and returns for the repairers' shed, is laid in trenching, with expansion loops placed 250 ft. apart. Near the end of the passenger-car paint shop is the storage space for mounted wheels, and close at hand is a drop-pit for use on cars which are not taken into the shop. This is operated by air-jacks and is a great convenience. For the convenience of the men about half of the repair yard has been completely planked over, which is an unusual provision and one which contributes greatly to the easy movement of material.

Electric lights are distributed all over the repair yard, so that work may be pushed at night as well as day if necessary. A feature of the track arrangement is the provision of a receiving and delivering track for coaches.

At the east end of the yard is the lumber storage, which is served by special tracks, over which a Garry pneumatic unloader travels and greatly reduces the amount of labor in handling lumber. This machine is served by a pipe line laid along the main tracks and provided with hose connections 50 ft. apart. The plant also has a 10-ton Brown locomotive crane for handling heavy material and trucks.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburg & Lake Erie Railroad.

BY R. V WRIGHT, MECHANICAL ENGINEER.

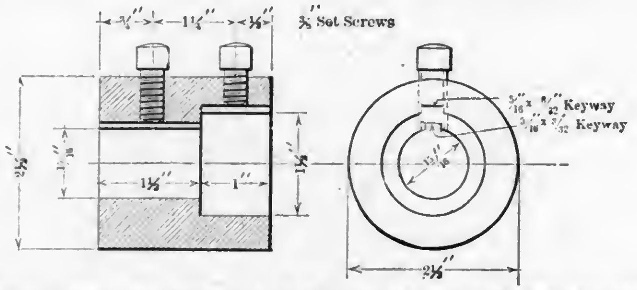
IV.

In locating the controller for a motor drive upon a machine tool, care must be taken to place it in as convenient a position for the operator as is possible. If this is not done a certain amount of time will be lost in making necessary speed changes, and it is possible that the operator, rather than inconvenience himself, especially if not working by the piece-work system, will not take full advantage of the opportunities presented by the close speed regulation available with the variable-speed motor.

On an engine lathe the most convenient position for the controller handle for operating the motor is, of course, upon the tool carriage, or apron, although it is not possible to locate the controller itself in that position on account of its large size; and, even if it could be so placed, the question of taking care of the wires, which must be attached to it to connect with switches, motor, etc., would be troublesome on account of the necessary traveling back and forth of the carriage. The usual practice is to place the controller at some point which is out of the way and arrange a connection to the controller handle on the lathe's apron by means of a spline shaft and one or two sets of bevel gears. This is the method that was used in the applications of motor driving to the old lathes at the McKees Rocks shops, several examples of which are herewith illustrated.

Fig. 18 shows such a controller application to an old 42-in. Niles engine lathe. The controller is in this case bolted firmly to the side of the lathe bed and the spline shaft is connected directly to the controller shaft by means of a special double wrought-iron collar, as shown in the accompanying detail sketch. A simple cast-iron bracket is used to provide bearings for the vertical shaft which carries the controller wheel, and also for the spline shaft. On account of the distance which the apron projects out from the lathe bed the controller could be applied, as shown, with the use of only one set of bevel gears, which is, of course, a distinct advantage, since additional gears increase the friction and add to the lost motion.

At times in the operation of a lathe, it is necessary for the workman to stop the spindle suddenly as the tool approaches a certain point. In such a case he must, of course, watch his work closely and will not be able to give much attention to the controller. If, in stopping the motor, the controller wheel is turned backward too far the motion of the spindle and tool will be reversed. To guard against this the upright handle is placed upon the rim of the controller wheel, as shown. This



DETAILS OF DOUBLE-WROUGHT IRON COLLAR FOR CONNECTING SPLINED CONTROLLER ROD TO CONTROLLER.

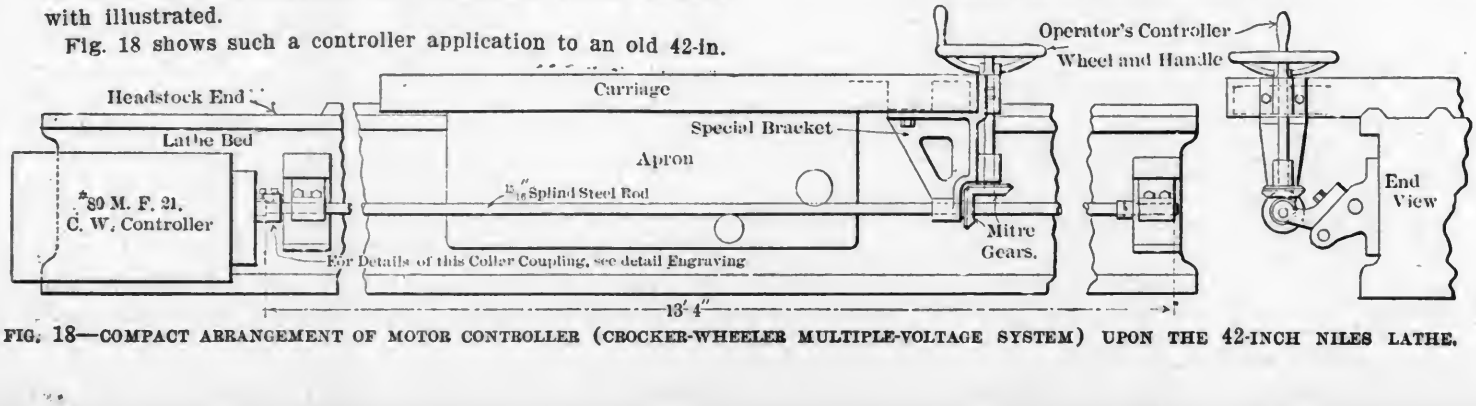


FIG. 18—COMPACT ARRANGEMENT OF MOTOR CONTROLLER (CROCKER-WHEELER MULTIPLE-VOLTAGE SYSTEM) UPON THE 42-INCH NILES LATHE.

projecting handle will always be in the same relative position when the motor is at rest, so that the operator will, with a little practice, be able to stop quickly at a given point. If the controller is so placed that the operator cannot see the dial on the end (which indicates the motor speed for each position of the handle) while using the handle on the apron, a set of figures can be stamped on the wheel and a pointer placed on the carriage or apron, near the edge of the wheel, and so that it will not interfere with the handling of the wheel.

Fig. 19 shows another controller application to a smaller lathe. The spline shaft, in order to pass behind the apron and be out of the way, must be carried close to the bed. In this case the controller is arranged to stand on its end on the floor, and is well braced so that it is rigid. It stands partly under the bed beneath the headstock and is thus out of the way. The objection to this arrangement is that oil and metal cuttings will fall upon it, but the controller can be protected from this at a small expense by placing a sheet-iron guard over it

The handle is placed at the lower right-hand corner of the apron because it is about the only point where it would not be in the way or interfere with other parts. It is not too low, however, for convenience.

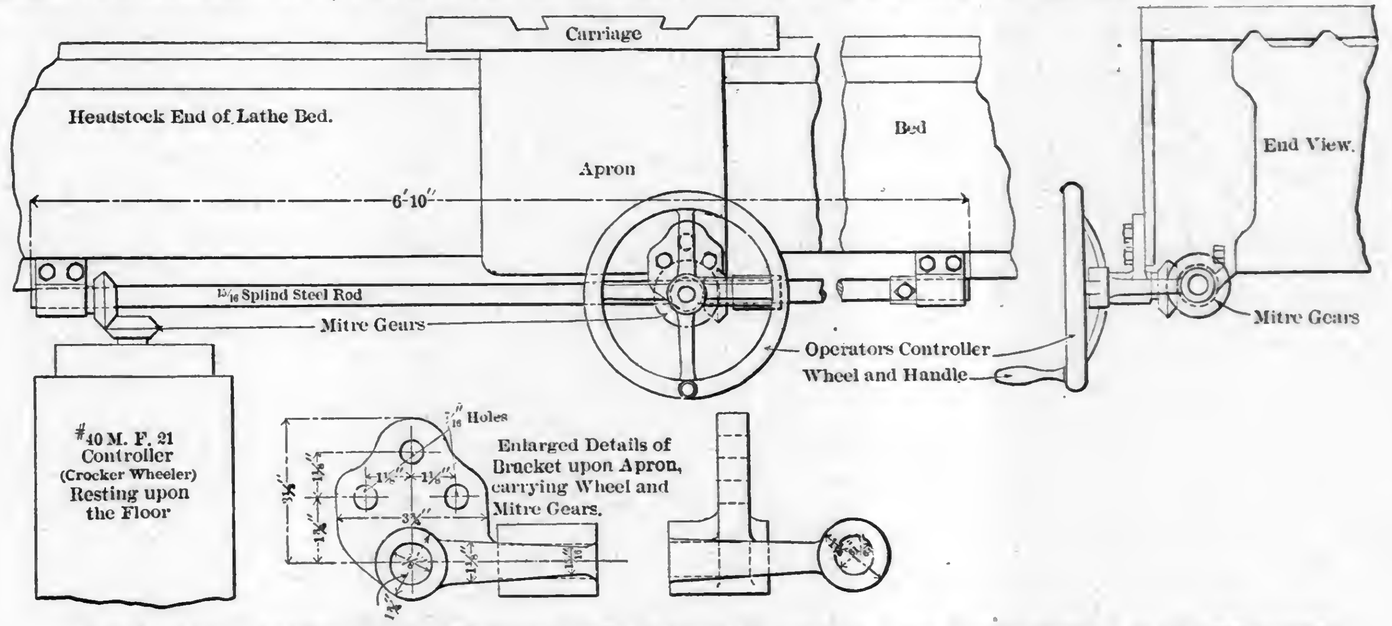


FIG. 19.—ARRANGEMENT OF MOTOR CONTROLLER (CROCKER-WHEELER) UPON THE FLOOR FOR USE WITH A SMALL REED LATHE.

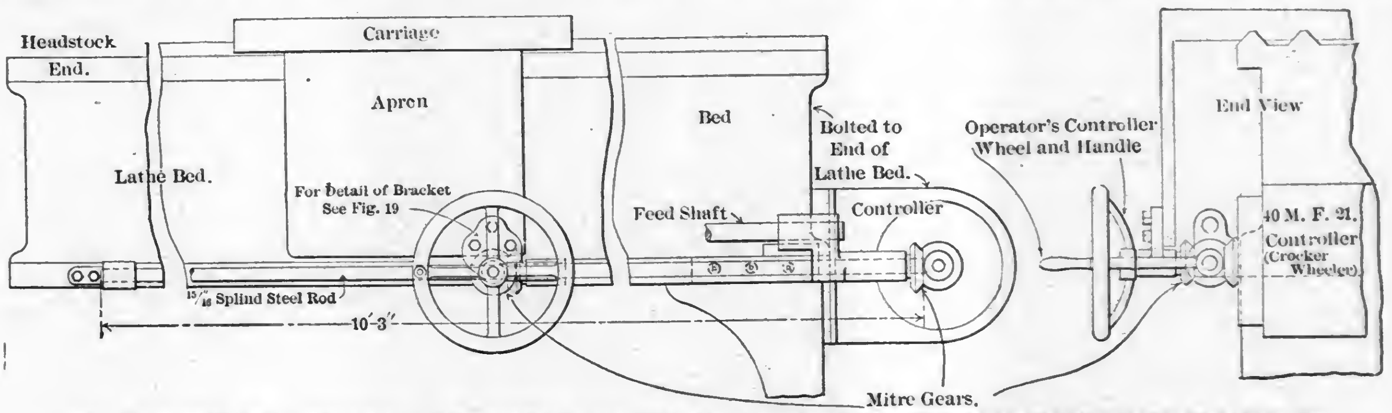


FIG. 20.—THE MOST CONVENIENT ARRANGEMENT FOR THE MOTOR CONTROLLER—CONTROLLER BOLTED TO END OF LATHE BED.

Fig. 20 shows still another controller application to an old lathe. The controller is here bolted firmly to the rear end of the lathe bed. At this point it is entirely out of the way, and furthermore, is not open to the objection cited against the arrangement shown in Fig. 19—it is located where no chips are liable to fall and is not liable to injury. This is undoubtedly the best possible arrangement for a controller for use upon a lathe and is to be recommended wherever possible.

(*To be continued.*)

Last month a demonstration of the possibilities of modern passenger transportation was made in moving the Dowie crusaders from Chicago to New York. Forty-one coaches and 20 sleeping cars were required for the host. They were handled in eight trains on eight different railroads at a cost of $40,000. They were all loaded at one point near Chicago and proceeded to New York in perfect order and without delays or accidents.

A 10,000-h.p. steam turbine, according to *Engineering*, of London, is being constructed by Messrs. Brown, Boveri & Co., of Baden, Switzerland, for service in Frankfort, Germany, with a guarantee of a steam consumption of 15.4 lbs. of steam per kw. hour, which is claimed to be equivalent to 8.8 lbs. of steam per indicated h.p. hour. This is the largest steam turbine unit thus far attempted.

A perfect balance of anything is difficult to obtain. This is particularly true of new shops. There may be said to be four chief factors in a complete shop plant, viz., buildings, equipment, personnel and management. Any lack in one of these affects the usefulness and efficiency of all of the others. In these days of improved buildings and machinery it is necessary that the importance of the other two factors should not be forgotten. Railroad shops are growing in a remarkable way. The officers in charge of them should have every encouragement to put them upon the plane of the most efficient manufacturing establishments and to obtain the perfect balance of the four factors mentioned. To be successful this must be done.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

AN HONOR TO THE EDITOR OF THIS JOURNAL.

At the Master Mechanics' and Master Car Builders' conventions, held in Saratoga last June, the railroad friends of Mr. G. M. Basford, editor of this journal, entirely without my knowledge, quietly developed a plan, to surprise him with an opportunity for a trip to Europe. The suggestion originated with Mr. W. S. Morris, of the Erie Railroad, and, without attempting to include more than a few of Mr. Basford's close personal friends, fifty-eight responded, and the list includes the names of the men who are best known in connection with railroad matters in the country. By a carefully conducted correspondence, Mr. C. A. Seley, of the Rock Island, brought the plans to conclusion October 7, when Mr. Basford was invited to a lunch at the Lawyers' Club in New York City, where he met a committee consisting of Messrs. W. S. Morris, J. F. Deems, C. A. Seley, L. R. Pomeroy and myself. Mr. Morris presented Mr. Basford with personal letters from all concerned, handsomely bound, and also a substantial check sufficient for a two-months' trip abroad. The first letter, which was signed by the entire number, reads as follows:

"To Mr. Basford:

"Your friends in railroad circles cannot find time to go across the water and study the late developments in locomotive practice. We therefore delegate you to do the work and tell us all about it in the columns of your valuable paper. We hope the execution of this commission, together with the ocean trip, will be pleasant and mutually profitable. With our best wishes accompanying you, and hoping that the trip may give you a full return of health and strength, we are

"Very sincerely your friends."

The intent of the plan is best expressed in the presentation by Mr. Morris, which was made in the following words:

"Mr. Basford:

"The gentlemen around you are not only your personal friends, but they are here to represent a host of admirers, whom you can with pride claim also as friends. We are here to tender not only our admiration of the efforts God has infused within your character and ambition, but to thank you in behalf of the many who have been instructed and benefited by your industry and faithfulness to the science through which we all claim kin to one another.

"In all probability this is the first time in the history of this generation, at least, that one has been so honored by the mechanical fraternity of this country, and we assure you it is extended with every thought of true manliness and absolute worthiness on the part of him to whom these words are addressed.

"To be plain, Mr. Basford, your friends feel that you have well earned some token of recognition at their hands, and we beg that you will accept this volume, which contains the sentiments, individually, of those whom the gentlemen here present have the honor to represent, and this, which is intended to give you a much-needed rest in the way of an extended trip to Europe; and, also, although perhaps selfishly, we hope that you may find some time to tell us of your travels and give some hints of interest which may be found on the other side.

"We wish you a prosperous trip, a safe journey, and a return denoting the fact that your friends have done the right thing."

After the presentation Messrs. Deems, Seley and Pomeroy endorsed and supplemented the remarks of Mr. Morris in a manner which was both genuine and touching.

As proprietor of the American Engineer and Railroad Journal, I endorse the sentiments expressed in this tribute to Mr. Basford with all my heart, and wish to thank each contributor for this mark of appreciation of one who has so indefatigably labored day and night in the interests of the associations and the motive-power departments of our railroads. Mr. Basford will sail in November.

R. M. VAN ARSDALE.

To My Friends:

Until Mr. Morris handed me the volume of letters I had no inkling of this. That such an honor should come to me in such a way is overwhelming, and I cannot understand it. That such men should unite in a word of friendly interest is the greatest honor, but that they should have and express the feeling which prompted these letters is the greatest joy of my life.

I cannot help saying that what success has attended my efforts is due to the support which friends have accorded and to the broad-minded policy of Mr. Van Arsdale in giving me the opportunity to work for them.

Most of the letters are inscribed "My Dear Basford." They are sacred, and my proudest possession. Not the least pleasing feature is that they come not only from railroad men and those who serve them, but also from the newspaper friends whom I most admire. Truly, no one has such cause for gratitude or such an inspiration for the future. With a heart full of love and gratitude for my many friends, I gratefully accept this token of their appreciation of my humble efforts, and I thank God for the opportunity to know and serve such men.

G. M. Basford.

HOW TO BECOME A SUCCESSFUL MACHINIST.

A boy of 16 was ambitious to become a machinist and had secured a position as machinist apprentice in a small plant consisting of a foundry and general machine shop. The night before he was to start to work he sought the counsel and advice of a friend of the family, a man whose ripe judgment and years of successful practice gave weight to his words. The advice, much different from what the young man expected, was:

"Young man, if you see a piece of work on the floor that has to be lifted and it takes more than one man to lift it, always be the first to take hold of it, don't let *anybody* get ahead of you; if you follow the spirit of this advice for four years you will come out a good mechanic."

SPACES BETWEEN SHOP BUILDINGS AND FIRE RISKS.

Locomotive erecting shops over 1,000 ft. long are big. When the other buildings of the plant are in proportion and a car department for building as well as repairing cars is added, the establishment becomes enormous. Designers of such shops have great responsibilities. The problem of planning a shop is not in direct proportion to the size of the plant. It is more difficult to design a large than a small one, because new questions arise in the large one which are much more important than the increased cost because of the size of the buildings. The matter of handling materials becomes a vital one in very large plants. Not only is it difficult to provide for material, but supervision such as is necessary in a railroad shop is difficult. A point has now been reached which justifies the question of how large it is profitable to build shops and how far it is advisable to concentrate work. The limit has been approached, if it has not been reached, unless a radical change in the arrangement of buildings is adopted. Isolated buildings have been favored on the basis of supposed reduction of fire risks. It is now in order to consider connected buildings with the type of fire protection which has been so thoroughly developed in modern mill construction. In this connection attention is directed to the fact that the new shops of the Locomotive and Machine Company of Montreal, which, while arranged so that the buildings are connected are accepted for insurance in the New England Manufacturers' Mutual Insurance Company, with an arrangement whereby an annual saving of over $6,000 per year is effected in the premium rates, making the rates that much lower than would be charged with the usual construction. That this conservative concern considers this connected arrangement of buildings such a good risk indicates the possibility that a mistake has been made in railroad shops having wide spaces between the principal buildings. This subject is worthy of attention. The shops referred to will be illustrated in this journal, when this subject will be more fully discussed.

"HAND HOLDS" ON LOCOMOTIVES.

The Interstate Commerce Commision is in an interesting situation with reference to the law requiring hand holds on the front ends of locomotives. Stated briefly, the circumstances are these:

The safety appliance law requires hand holds on the ends and sides of all cars except passenger cars. An amendment to the law passed last April classified locomotives as cars with respect to safety appliances. The question of standard location of hand holds on locomotives and tenders is now up for discussion.

The commission has already waived the requirement as to the hand holds on the sides, near the ends, of locomotives, which indicates the fact that the whole matter, as far as locomotives are concerned, may be waived at their discretion. It therefore appears that the law need not be enforced as to the front hand holds on the pilots.

As indicated in public discusions, many railroad officers wish to discourage riding on the pilots of locomotives and object to the hand holds on the ground that they would encourage a dangerous practice. If the railroad men are right in this and if the law is enforced, the commission may place itself in the attitude of increasing the hazard of the men by enforcing the safety appliance law, which was intended to decrease the dangers of their occupation. In such a case the moral responsibility would appear to rest upon the commission. We shall be glad to print opinions of our readers upon this subject.

TWO LEAKY TUBE SUGGESTIONS.

Flue troubles are everywhere apparent. They do not seem to be confined to any particular road or type of firebox, and yet with the introduction of wide fireboxes there seems to have been an increase of the amount of difficulty. When fireboxes were always deep and the fires were also deep on the grates, tube leakage was not as serious as it is with larger grates and shallower fireboxes. The matter of distance of the tubes above the fire has something to do with this. If the distance is sufficient the heat of the fire will evaporate a certain amount of leakage and it will not deaden the fire, as is the case when the water runs directly upon the coal. Again, if the fire is thick a little water will not quench it, as is the case when it is very thin. But this has nothing to do with the trouble itself.

Tubes leak, and this should be prevented if possible. At least two things can be done at once, and both seem likely to afford relief. The first is to camber the tubes, giving them an even curve, with the center of the tube, say, 1 in. off that of the ends. This has been done in England, but the degree of cambering may not have been exactly this. Such curving of the tubes may provide a means for taking up expansion and contraction without affecting the sheets. It is worth trying.

The other precaution relates to the handling of injectors when the engine is not using steam. Experiments on a Western road have shown that when an engine is standing at a station or in the roundhouse, and not using steam, it is possible by using the injectors, under such conditions, to produce a difference of temperature of 100 degs. between the water at the crownsheet and that at the mud ring. If the same difference exists at the tubes, the lower tubes, if about 18 ft. long, may be expected to be ⅛ in. shorter than the upper ones. This is sufficient to account for some of the flue troubles. When the engine blows off or for any reason the natural circulation is restored, the feed-water mixes thoroughly and the wide range of temperatures is destroyed. This suggests the importance of feeding boilers only when the water is in active circulation. This cannot always be done, but by liberally educating engineers and hostlers, a marked improvement is possible.

These suggestions are not new but the reader will not object to being reminded of them.

COMMUNICATIONS.

THE HEAVIEST LOCOMOTIVE.

To the Editor:

On page 372 of your current number you give credit to the new "Santa Fe" type locomotives, built by the Baldwin Locomotive Works for the Achison, Topeka & Santa Fe, as being the heaviest locomotives in the world. These engines have a total weight of 287.240 lbs., of which 234,580 lbs. are on driving wheels. Your statements are generally correct, but here you are wrong. The Shay locomotive, which you illustrated in August, 1902, weighs 291,000 lbs., all of which comes upon the driving wheels.

ACCURACY.

[The geared machine referred to was called a locomotive in this journal with misgivings at the time. It is really not a locomotive at all, but a movable steam capstan on wheels with a locomotive boiler.—EDITOR.]

GOOD WORK OUT OF AN OLD SHOP.

To the Editor:

Some months ago a progressive and bright master mechanic said to the writer: "You have been illustrating and describing new and modern shops, now write something explaining how to get the requisite amount of work out of an old shop at the minimum of cost."

This master mechanic was on a large, important road that had two shops—one quite new and modern, the other small, crowded, badly equipped and lacking important tools and appliances. The old shop was turning out—thanks to this master mechanic's ability—pretty nearly as much per month as the new one, and was doing it at about the same average cost, but as soon as the organization of the new shop is perfected the old shop will not be able to compete.

There are several important rules to be observed to get the maximum amount of work at the minimum of cost.

First, the superintendent of motive power must take an active interest and be open to suggestions from his subordinates; second, the master mechanic, the superintendent of shops and the general foreman should also be alert and alive and should graciously receive suggestions; third, a good organization should be perfected.

As to this last, it may be said that this is the secret of it all. The general foreman, the machine shop foreman, his assistant; the floor or erecting shop foreman, his assistants; the gang foreman, the boiler maker foreman, his assistant; the blacksmith foreman, the chief electrician, the foreman of the mill, the tool room foreman, the pattern maker foreman and the foundry foreman should be called together in a meeting, the superintendent of shops or general foreman acting as chairman. The purposes and plans of the meeting should be explained and discussed. These meetings should be made enthusiastic, the work outlined, opinions should be asked of each general and other foreman, according to their seniority.

Right here it is well to say that the writer believes that a gang foreman should be a salaried man. He should be a carefully selected young man, who should be given to understand that it is "up to" him to hold the men in line, by enthusing them; also that he, the gang foreman, being made a salaried officer and belonging to the official staff of the shop, must take a big interest in the success of the shop and in turning good work out at a minimum of cost. If he cannot hold his end up another should be tried. This foreman should be made to feel that he will be promoted to the position of general foreman if satisfactory, and that other responsible positions will be open to him if he is successful.

The meetings of these foremen should be held once every week, an hour or so before quitting time. A general shop meeting of all that are interested might be held three times a year and an address made by the superintendent of motive power.

The superintendent of shops or chairman of meeting should have all engines or cars booked each week and should give notice when they are coming into the shop. The man in charge of stripping should be told that only a certain number of hours at the most would be allowed. The storekeeper should be advised and should keep in stock everything that is needed. The machine shop foreman and floor foreman should call for what is needed in time so that he can procure the material if it is not in stock.

All foremen should be earnestly advised to take an interest in the railway clubs, and it should be insisted upon that they read and subscribe for some good mechanical railway paper. Finally, all should study plans for new and better arrangements of tools, to try to impress the management with the necessity for traveling cranes if they are not alreay provided, and also plan to drive their old tools by electric motors.

GEORGE B. SHANE.

ILLINOIS CENTRAL SUBURBAN CARS.

To the Editor:

I note with considerable surprise your fulsome praise of the new Illinois Central suburban cars on the editorial page of your October number. There is nothing new about these cars, and I fail to see how you can say that they are likely to influence future construction except unfavorably. In the first place, these are English cars, and therefore old in principle. They are inordinately heavy, and this is a step in exactly the wrong direction. Furthermore, they require station platforms raised to the level of the car floors. This may be convenient for such a road as the Illinois Central, but it will not do at all for Eastern roads where the suburban and through service must be handled on the same tracks. I fail to see the point of your pleasant remarks about these cars, and do not believe this type of car will ever appeal to railroad men, either those in charge of surface or elevated lines; in fact, looking at the car from the standpoint of a practical superintendent, I can see nothing in it.

SUPERINTENDENT.

[The frank disapproval of this correspondent indicates that he has not watched the retrograde movement of the past ten years in suburban traffic on steam lines with sufficient care. He must be told that the methods of these lines must be revolutionized or suburban business will soon be irretrievably lost to electric lines where the principles of convenience are understood. These cars are new and are not "English." The combination of the aisles and transverse seats, with doors opposite the seat spaces, is new and necessary. The capacity of suburban trains is not now limited by acceleration or by speed between stops, but by the rapidity of loading and unloading of passengers at stations, and here is where the Illinois Central cars surpass those of all other types. As to the weight, let us ask our correspondent to point to any other suburban car of this length or any other length, having a capacity to seat 100 passengers. Per unit of weight per passenger, this is now a light car. Let us ask him to point to a stronger car than this, and remind him of the way in which ordinary suburban cars of wood are crushed in collisions. The Illinois Central cars are not as light as they may be built. They may be constructed almost entirely of steel, and undoubtedly this is the direction which the first improvements will take. This journal stands pat on the "fulsome praise" already given, and advises railroad officers to take a leaf out of the Illinois Central book as to methods of handling large numbers of suburban passengers. If this business is to be retained, other roads must follow this leadership until something better appears.—THE EDITOR.]

SOME CAUSES OF BREAK-IN-TWOS.

To the Editor:

The following figures may be of interest in connection with the figures shown in the digest of the proceedings of the Traveling Engineers' Association, published in your October issue, concerning the cause of break-in-two's.

Record of break-in-two's—from January 1, 1900, to October 10, 1903:

Running between stations, air not in use	25%
Air applied and released	17%
Air applied, rear cars going into emergency	6%
Starting train	48%

You will note that practically one-half of the break-in-two's occur in "taking up the slack" when starting the train; also that the failures while "running between stations, air not in use," are 50 per cent. greater than the failures caused by delayed release in long trains.

The number of cars in a train ranges from 20 to 75; the average being over 40. The air-brakes are used in most cases on all the cars in the train; except when there are over 50 cars.

In 228 cases where the direct cause was not obscured by subsequent "running together," the causes were as follows:

Broken coupler	61
Broken knuckle lock	4
Broken yoke, stem, or stem key	24
Worn out knuckle	1
Worn out knuckle pin	1
Knuckle came open, old coupler or creeping of lock	29
Contour line worn	3
Broken draft timbers	10
Broken draft rods	1
Broken knuckle	44
Broken knuckle pin	5
Broken yoke bolts or rivets	5
Worn out knuckle lock	9
Couplers under standard height	1
Knuckles sliding by	12
Defective brakes	7
Wrong use of brakes	11

A. M. ORR.

HEAVY FREIGHT LOCOMOTIVE.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

2—8—0 TYPE.

The proprietor and editors of this journal take special pleasure in presenting this locomotive because it is the first to be fitted with a stack in accordance with the formula derived by Prof. Goss from the AMERICAN ENGINEER tests. (See AMERICAN ENGINEER, June, 1903, page 240.) It is too early to state the results in steaming qualities, but the first locomotive to go into service has done well thus far. We illustrate the stack and front end arrangement in this issue.

In the Lake Shore classification this is known as a "130 per cent. engine" and is designated as Class C. The "100 per cent." engine of this road is the one illustrated on page 37 of this journal for February, 1900. A locomotive having a weight of 207,000 lbs. on driving wheels is a large one, and is probably large enough for any ordinary road to use for the present, until the necessity for improving round house and shop facilities is better appreciated than is the case at present. That the "Lake Shore" should build five such engines will surprise many who are familiar with the early traditions of this road with respect to light locomotives. On the low grade division such heavy units are not needed. These are to be used in pusher service on the hills at Youngstown and Ashtabula, on the Franklin division. This division has a low grade line of about 0.3 per cent. with the exception of the hills at each terminal, where the grades are such as to require three road locomotives to handle a train which is easily handled by one of them between terminals. They are also to be used to push freight trains from Cleveland to West Park, on the Toledo division. Further work for which they are adapted will appear in the new gravity or "hump" yards at Collinwood and Elkhart when these yards are completed. At present they will not be used in main line service on the Franklin division, but when steel cars of 100,000 lbs. capacity are sufficiently numerous on that division to bring 4,000 ton trains down to a reasonable length they will be put into regular road service, for which they are admirably adapted. This division handles coal to Ashtabula and ore toward the south to Youngstown.

These locomotives were built at the Brooks Works of the American Locomotive Company. They are specially interesting because of the attention which was given to the details, and for which credit is due Mr. H. H. Vaughan, assistant superintendent of motive power of the road, and also to the builders. These are the first locomotives having 6-in. frames throughout. This, however, is but one feature of the frame system which will be brought out in the presentation of some of the details of construction in our next issue. Considering the fact that the designer was required to work within positive limits of weight, height and width, and that the engines are to work in exceptionally severe service, this production is a remarkable one.

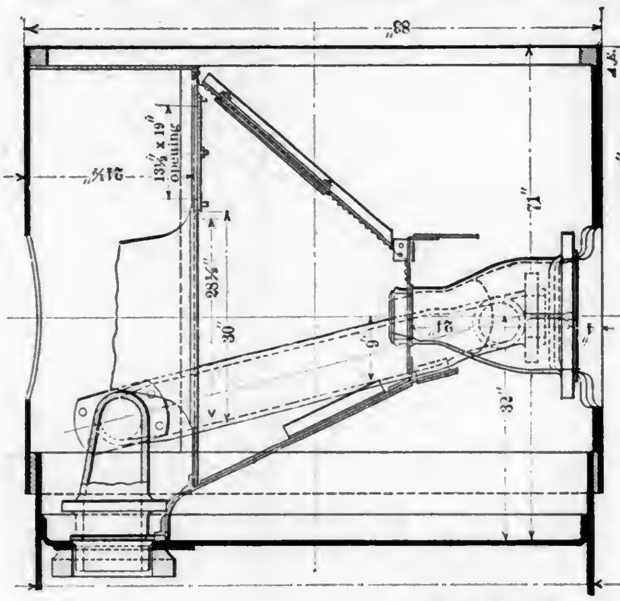
These engines have cylinders, 23 x 30 in., drivers 57 in. diameter and weigh in working order 235,400 lbs., 207,000 of which is on the drivers. The boiler is a radial stayed wagon top with wide firebox, 109 in. long by 74 in. wide, the diameter at the front end of the boiler 80 in. and diameter at largest course 87½ in., and is provided with 460 tubes, 2 in. diameter by 15 ft. 6 in., long spaced with 15-16 in. bridges. The water space in the throat sheet leg especially is made very wide so as to provide ample means for circulation, the feature in the design of this boiler being not so much to provide an abnormal amount of heating surface as to furnish a sufficient amount properly arranged so as to give ample means for circulation and thus secure greater efficiency. One of the features in the design of this boiler is the use of very large radius in the upper corners of the flue sheet and door sheet.

The frames are of cast steel, made solid throughout without splices; the front end consisting of a combination casting forming a bed plate for the cylinders and engine truck spindle guide and frame bumper bracket all in one piece, this being securely bolted between the frames and to the cylinders; the frames being 6 in. wide throughout, but being only finished on such portions as absolutely required on the frame and the unfinished portions being made narrower, so as to permit of continuous finish. The frames are braced together at intervals throughout their length by heavy steel castings, the forward one of which at the rear of the front pedestal being arranged vertically so as to absorb any thrust or twisting strains.

The link motion is of the central direct type with double hangers, the transmission bar being coupled to an inverted rocker, attached to the guide yoke, the rocker having external bearings. The engine truck is of new design and will be illustrated in detail. It consists of a cast steel frame with coil springs on top of the boxes, thus dispensing with the usual equalizers and side springs, and enabling the frame to be made much lower and provide more clearance for the engine frame. The swing beam is also of new design, providing for long three-point suspension hangers on either side of the axle thus insuring ample motion to the truck, without too great resistance. The dry pipe is 9 in. diameter, and is provided with an improved top opening throttle of ample capacity. The smoke box arrangement is somewhat peculiar, consisting of a solid horizontal partition below the tee head, the smoke stack being extended down through the arch and bolted solid to this horizontal diaphragm, the usual smoke box arrangement being provided for underneath this diaphragm. This arrangement enables the use of a fairly long stack without having the bottom extend below the solid surface of the smoke box.

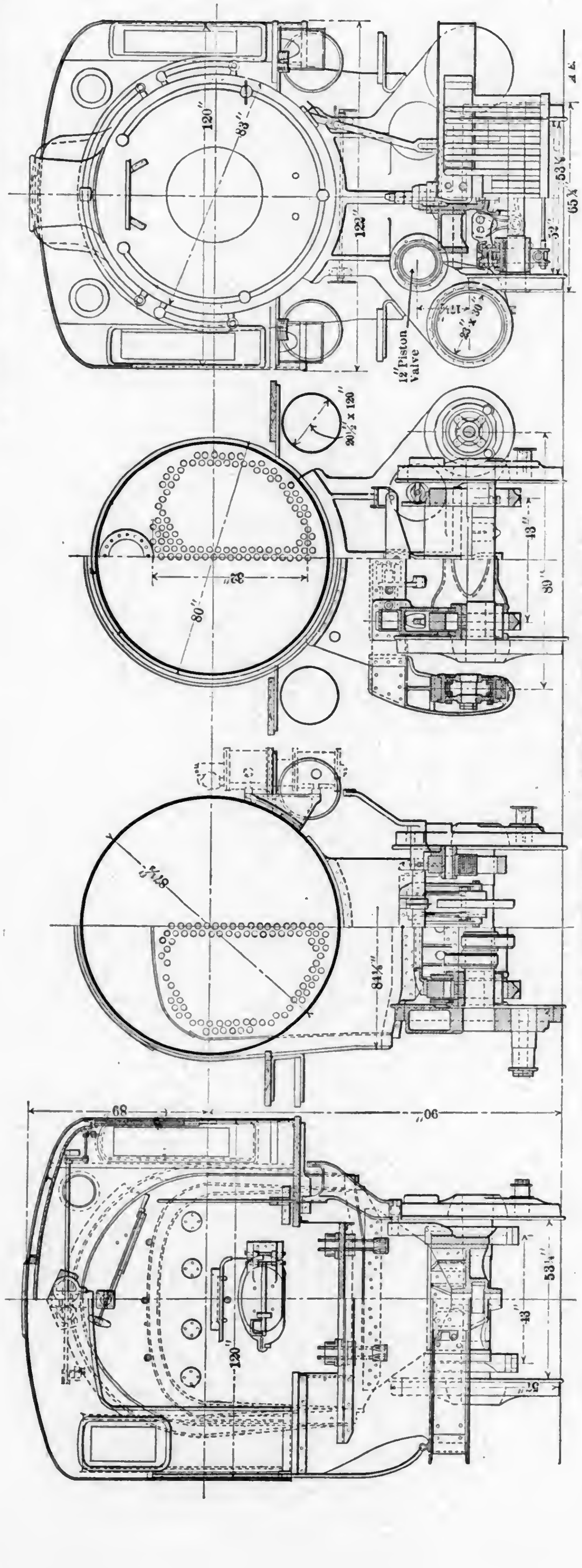
The cab is of steel proportioned to suit the other dimensions of the engine, and having the front doors set on an angle opening inwards in order to provide sufficient opening with the extremely wide firebox used. Brake reservoirs are located underneath the forward running boards on either side. The feed water is supplied through two No. 11 non-lifting injectors, it being impracticable to apply two lifting injectors and provide suitable room in the cab. The water from the injectors is delivered through a special tee fitting attached to the bottom of the boiler waist at the front end, this being provided with a horizontal discharge elbow facing towards the firebox, the delivery of feed water thus being arranged as nearly as practicable in the line of proper circulation, furthermore, the cooler feed water from the injectors has a tendency to keep down the temperature of the firebox flue sheet and the back end of the flues ,especially when the engine is working hard. The back end of the frames is dropped down so as to bring the line of draught as nearly as practicable in line with the centers of the axles; the tender frame also is made extremely low for a tender of this size, thus keeping down the center of gravity of the large tank used as well as keeping the center of the draught at the rear end inside the line of the frame, instead of below as is usually the case. In order to accomplish this a special design of frame as illustrated on the drawings together with special design of tender truck having low cast steel bolster is used. There are many features of design differing somewhat from other heavy engines, one of the most noticeable being that notwithstanding the enormous size and proportions of the engine, yet all parts are as readily accessible for inspection, repairs or renewals as upon engines of half the weight, whilst the cab is fully as roomy, and the arrangements just as convenient as upon smaller engines.

In describing the details of the design next month attention will be directed to many interesting features, among which are: 13-in. piston valves with internal admission, English links, a new construction of rockers and rocker boxes, the Player 4-chamber exhaust pipe, unusually careful frame construction and bracing and an excellent new ash pan construction. The accompanying tables present the ratios and principal dimensions of these locomotives.

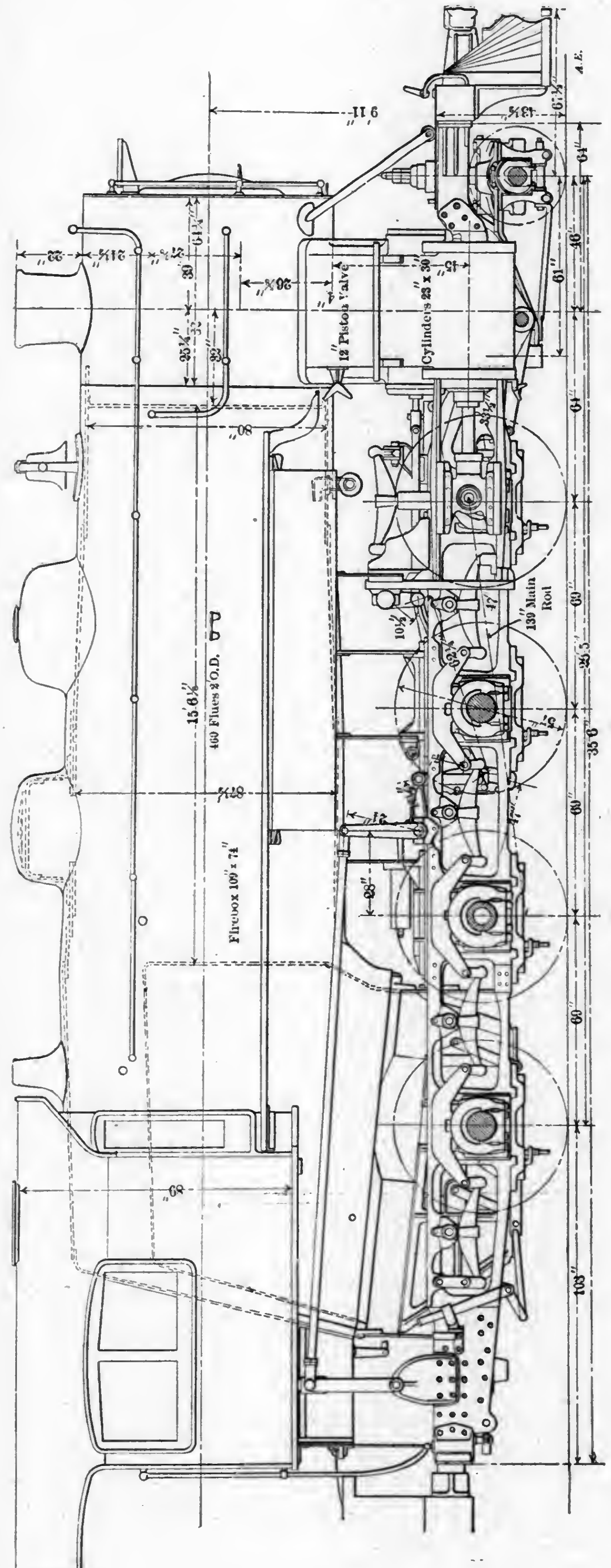


FRONT END ARRANGEMENT, SHOWING HORIZONTAL PARTITION.

FROM A PHOTOGRAPH.

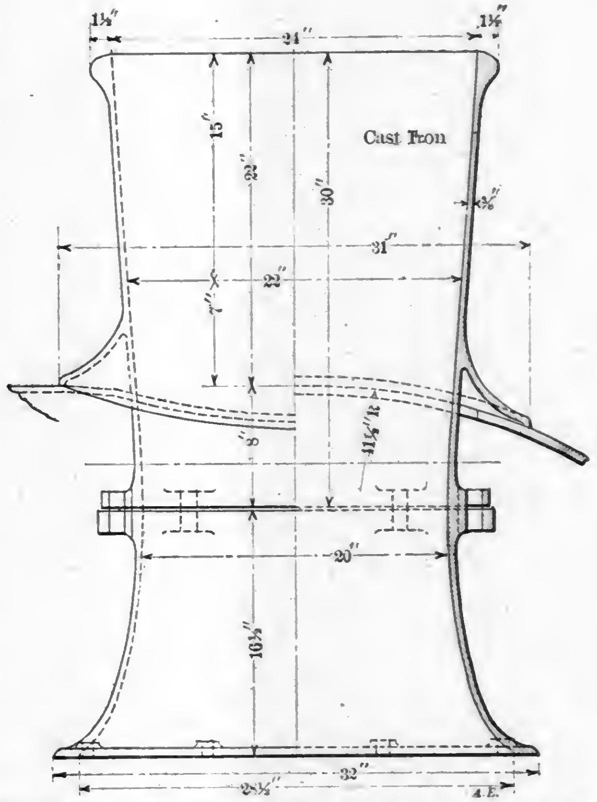


LAKE SHORE FREIGHT LOCOMOTIVE SECTIONS AND END VIEWS.

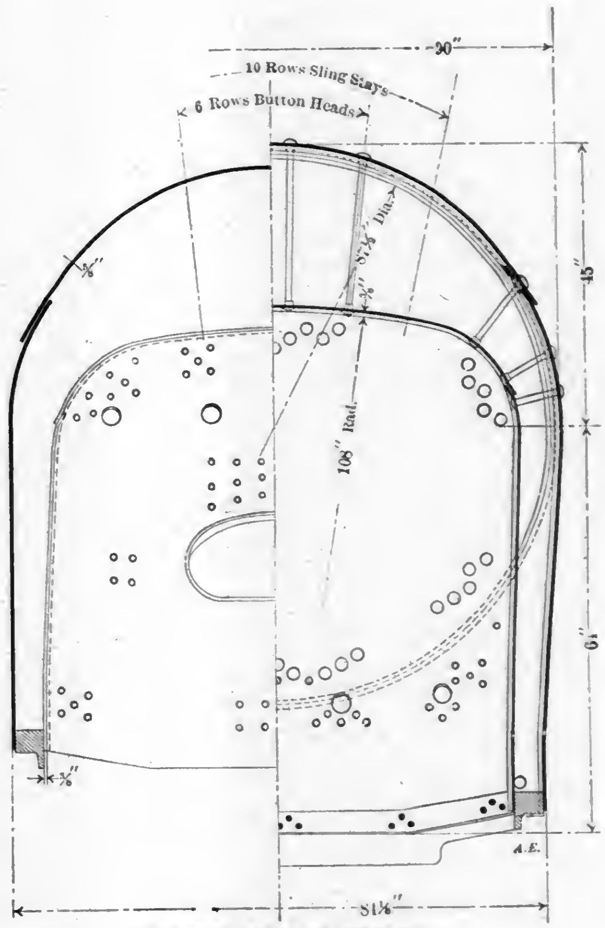


CONSOLIDATION (2-8-0) FREIGHT LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

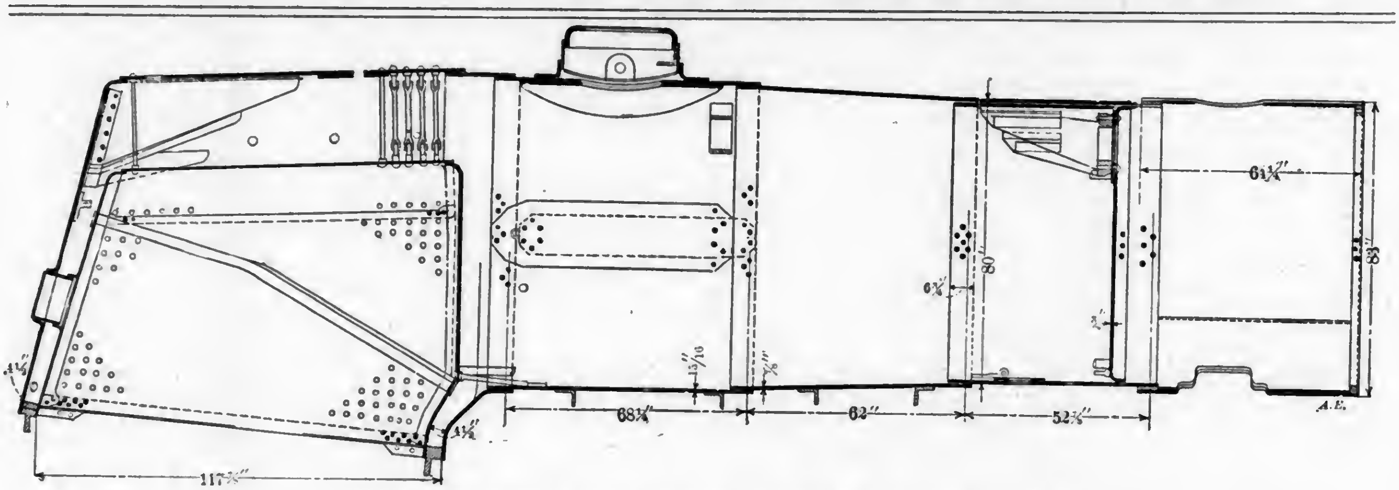
H. F. BALL, *Superintendent Motive Power.* H. H. VAUGHAN, *Assistant Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY—BROOKS WORKS, BUILDERS.



THE STACK—DESIGNED IN ACCORDANCE WITH AMERICAN ENGINEER TESTS.



SHOWING FORM OF FIREBOX.



FREIGHT LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

LAKE SHORE AND MICHIGAN SOUTHERN RY.

2—8—0 FREIGHT LOCOMOTIVES.

RATIOS.

Heating surface to cylinder volume	= 274.8
Tractive weight to heating surface	= 52.3
Tractive weight to tractive effort	= 4.37
Tractive effort to heating surface	= 11.95
Tractive effort + dia. of drivers to heating surface	= 681.3
Heating surface to tractive effort	= 8.4%
Total weight to heating surface	= 59.48

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ in.
Fuel	Bituminous Coal.
Weight in working order	235,400 lbs.
Weight on drivers	207,000 lbs.
Weight Engine and Tender in working order	386,400 lbs.
Wheel Base, Driving	17 ft. 3 in.
Wheel Base, Rigid	17 ft. 3 in.
Wheel Base, Total	26 ft. 5 in.
Wheel Base, Total, Engine and Tender	57 ft. 10 in.

CYLINDERS.

Diam. of Cylinders	23 in.
Stroke of Piston	30 in.
Horiontal thickness of Piston	7 in.
Diam. of Piston Rod	4¼ in.
Kind of Piston Rod Packing	U. S.
Size of Steam Ports	29¼ in × 2 in.
Size of Exhaust Ports	65 sq. in.
Size of Bridges	4 in.

VALVES.

Kind of Valves	Piston.
Greatest Travel of Valves	5 7-16 in.
Outside Lap Valves	1 in.
Lead of Valves in full gear	1-16 in.
Kind of Valve Stem Packing	U. S.

WHEELS, ETC.

No. of Driving Wheels	8
Diam. of Driving Wheels outside of Tire	57 in.
Mat'l of Driving Wheel, Centers	Cast Steel
Thickness of Tire	3½ in.
Driving Box Material	Cast Steel
Diam. and Length of Driving Journals	9½ × 10 in. dia. × 12.
Diam. and Length of Main Crank Pin Journals	7½ in. dia. × 7.
Diam. and Length of Side Rod Crank Pin Journals	8¼ in. dia. × 5½.
Engine Truck, journals	6 in. dia. × 12.
Diam. of Engine Truck Wheels	33½ in.

BOILER.

Style	Radial Stayed Extended Wagon Top.
Outside diam. of first ring	80 in.
Working Pressure	200 lbs.
Thickness of plates in barrel and outside of fire box.	13-16, ⅞, 15-16, ⅝, 9-16, ⅝ in.
Fire Box, length	109 in.
Fire Box, width	74 in.
Fire Box, depth, Front	83½ in. Back 69½ in.
Fire Box plates, thickness, sides,	⅜ in. back, ⅜ in. crown, ⅜ in. tube sheet, ⅝ in.
Fire Box, Water Space	front, 4½ in., sides, 4½ in., back, 4½ in.
Fire Box, Crown Staying	1 in.
Fire Box, Stay Bolts	1 in.
Tubes, material and gauge	Steel.
Tubes, number	460
Tubes, diam.	2 in.
Tubes, length over tube sheets	15—6⅛ in.
Fire Brick, Supported on	Four 3-in. Tubes.
Heating surface, tubes	3,725 sq. ft.
Heating surface, water tubes	29 sq. ft.
Heating surface, fire box	203 sq. ft.
Heating surface, total	3 957 sq. ft.
Grate surface	55 sq. ft.
Grate, Style	Rocking.
Ash Pan, Style	Hopper.
Exhaust Pipes	Single.
Exhaust Nozzles	6¼ in.
Smoke Stack, inside diameter	20 × 24 in.
Smoke Stack, top above rail	15 ft 2½ in.
Boiler supplied by	Two No. 11 New Nathan Injectors.

TENDER.

Style	Eight-wheeled.
Weight, empty	56,580 lbs.
Wheels, number	8
Wheels, diam.	33 in.
Journals, diam. and length	5½ in. dia. × 10 in.
Wheel Base	18 ft. 0 in.
Tender Frame	13-in. Channel Steel.
Water Capacity	7,500 U. S. gallons.
Coal Capacity	16 tons.

POWER TO DRIVE MACHINE TOOLS.

To the Editor:

It is by no means a rare thing to find in your journal something that gives us food for thought. This time it is that cylinder borer of which you gave an account in the October number. It is said that he who causes two blades of grass to grow where but one grew before, is doing good work; but here some one has done more, they have caused about four cylinders to be bored where but one was bored before. The increase of output in this instance is somewhat remarkable. What particularly interests me is to know how much power is required to do the work mentioned? You state that a 5-h.p. motor ran rather warm. I believe it. A few figures show that with a cut ⅜ in. deep and a feed of 5-16 in., about 35 cu. ins. of metal were removed per minute. Upon this basis, and upon the assumption that the machine requires but a small amount of power to run it light, and also assuming that the tools are kept in well-sharpened condition, I have estimated that about 9 h.p. are required. This is from an arbitrary formula, which has held good in a few instances, but is not of universal application. Another formula would indicate that a power of 17.5 h.p. would be required for this work. From another authority we learn that 21.9 h.p. are needed. These figures show quite a variation, but here is another one which, when worked out seems to think that about 19.2 h.p. will answer, and upon reference to a well known pocket book, 16.5 h.p. looks to be the proper thing. Four of these results are from published formulæ. Now who is guessing?

There is truth somewhere in this problem, and we would like to find it, for if the operator can do twice the present amount of work, if given a larger motor, then how large should it be, 18 h.p. or 44h.p., and he should have it quickly to make up for lost time. Evidently the motor now in use is under rated. It would be of interest to have reliable readings that would show what is being done, and how close some of us are guessing. Another thought—with the reduction of time, has a high quality of work been retained? Are the cylinders true in diameter and of uniform size through the length of bore? Are they smooth and easy upon the piston? If so, then well and good, but if not, then perhaps it would be better to ease up a little on the time and improve the quality. Other thoughts have suggested themselves—but I fear that waste basket.

M. E.

ACTION OF THE NEW TOOL STEELS.

The new tool steels contain—in addition to iron and carbon—chronium, tungsten, and sometimes titanium and molybdenum, and Mr. Spuller's view is that, in the point of the tool, the excessive heating causes a portion of the carbon to leave the iron and form high carbides of chromium and tungsten. These higher carbides exist in the form of needle-like crystals of intense hardness, which are embedded in the soft iron carbide as in a matrix, and which form the real cutting portions of the tool. This view is supported by the fact that the points of these tools harden in use, and also by the form assumed by the tool points after heavy service; but it cannot be said to be absolutely proved, and the assumption that the formation of the crystals of chromium and tungsten carbides is due to the heating alone does not seem to satisfactorily explain the difference which apparently exists between the point and the immediately adjacent portions of one of these tools. There is, however, another action going on which may, I think, exert an important influence, and that is the extremely intense pressure to which the point of such a tool must necessarily be subjected. Of course, this is merely a suggestion, but I think it not improbable that further research may show that intense pressure and heat in combination can produce an effect which would not result from heating alone.

However this may be, the fact remains that we have in these new steels a series of materials which promise to revolutionize a very important percentage of our machine work, and to necessitate very material alterations in the proportions of our machine tools, involving very heavy outlay, if we wish to advance with the times. Now, these are facts pointing to the necessity for extensive research conducted in a thoroughly systematic way. Of course, such an inquiry as this would involve considerable expenditure; but the interests involved are enormous, and it cannot be doubted that the results attained would not only be of great immediate value to both steel makers and steel users, but would also lead to important advances in the early future.—W. H. Maw, before the Institution of Civil Engineers.

FROM MR. FORNEY.

Mr. M. N. Forney recently handed a clipping tc the editor of this journal without comment, but comments may be forthcoming. The clipping contained the following:

"Edison abhors cigarettes. Recently one of his clerks dropped a package just outside the private office door. Next morning the offending box of cigarettes was found impaled with a nail, from which was suspended the following notice:

"'A degenerate who is retrograding toward lower animal life has lost his packet.'

"There was no mistaking the familiar handwriting. It hung there all day.

"Next morning the cigarettes were gone, but a big black plug of chewing tobacco was there instead. But not for very long.

"Edison chews tobacco."

Mr. Howard Elliott has been elected president of the Northern Pacific to succeed Mr. C. S. Meilen, who recently resigned to succeed Judge Hall as president of the New York, New Haven & Hartford. Mr. Elliott leaves the position of second vice-president of the Chicago, Burlington & Quincy.

The Northern Railway of France has put into service a steel car having a capacity of 50 metric tons. This is the first large capacity car in France. It is of steel plate, of the Fox type, and constructed by M. P. Arbel, the licensee for this construction in France.

Professor Robert H. Thurston, Dean of Sibley College, Cornell University, died suddenly at his home in Ithaca Sunday night, October 25.

THE VALUE OF TECHNICAL TRAINING.

Commenting upon the field for the educated engineer in manufacturing establishments, Prof. J. J. Flather, of the University of Minnesota, made the following remarks before the North West Railway Club:

"I am reminded that a number of years ago there used to attend the Boston 'Tech.' a young man who got acquainted with an old manufacturer whom he met daily going to and from the school. This old gentleman, who had been in the manufacturing business for some forty years, was very much interested in my young friend and followed his career through college. When the young man graduated he went out to the factory and wanted to hire out as a mechanical engineer. He had just had his sheep-skin and felt very wise, as he undoubtedly was. The old man said he had been in business for forty years; he had made money; was then making money; he had never needed a mechanical engineer; he didn't see what the use of such a being was, and he had no use for his services. 'But,' said the boy, 'your valves aren't working right; look at your exhaust and listen to it; your line shaft is out of line; there are lots of things here that need a mechanical engineer; you could make money.' He said, 'I am making money, I have been making money for forty years; I don't need a mechanical engineer.' Said the young man: 'I don't suppose you have any objection to my working for nothing. I would like to go to work and adjust things; I would like to overhaul your valves; I think I can show your firemen how to save coal; I think I can get you better results. I am willing to make this proposition: I won't ask any salary, and if I can save you anything just turn it over to me.' Well, the old gentleman said that was fair enough, so met the proposition of the young man that he shoud have what he saved during the first year. The young man came down to the shop and began his work of overhauling and bricked up the fire-grate and made it a little smaller, and he gave the firemen some orders about firing and looked after the shafting and the pulleys, and the old man saw that his coal bill was not quite so great as it used to be and he gave the young man an allowance of the amount, and at the end of the first year the young man drew out $6,000, which had been saved in fuel and other expenses that had been expended previously. It is not necessary to say that at the end of the year the young man was engaged as mechanical engineer. He started in on the second year not at $6,000, but at $2,500 per year, and is now a partner in the firm."

A NOVEL METHOD OF PIPE THREADING.

The method of pipe threading referred to is no doubt better "honored in the breach than in the observance"; however, it points a valuable moral, as will be seen.

The reminiscence is related by a one-time superintendent of water service, the incident occurring some twenty-five years ago on a road entering Chicago. Receiving advice that the water pipe was leaking at an important water station, the superintendent of water service went at once to the scene, with such men and tools as he had with him. Arriving at the water station he found the 4-in. wrought-iron water pipe broken squarely off, only 2 ft. of water in the tank, and no means of getting a piece of pipe from any shop cut to length and threaded inside of twenty-four hours. Unwilling to interrupt the water supply and determined not to acknowledge defeat until the last resource was tried, he cut a piece of pipe to length with cold chisels, chalked the unthreaded end, placed it in line end to end with a threaded old piece of the same size pipe, and with two-pointed tram, one point engaging in the thread of the old pipe, the other scribing on the chalked end of the blank pipe, he followed the thread with one point, always keeping the tram parallel with the axis of the pipe. The path of the right pitch thread was thus scribed by the tram point on the chalked surface of the blank end of pipe requiring thread. The spiral scribe mark thus made was nicked with chisels, deepened and made continuous, until at

the end of an hour and a half a good thread was cut, the job put up without a drop of leakage and without the interruption of the water service.

The above incident was modestly related on its own merits as an ingenious little mechanical makeshift, but it is of greater interest as symbolizing that high attribute of generalship which shrinks not in the face of difficulties, but which with skillful use of the means at hand snatches victory from defeat:—Resourcefulness.

RECORD-BREAKING TIME IN BORING DRIVER TIRES.

A Boring-Mill Operator Who Keeps Four Men Busy Handling Work.

WEST ALBANY SHOPS.—NEW YORK CENTRAL.

The letter appended below is a remarkable statement recently received relative to an astonishing boring-mill record that is being maintained in daily service at the New York Central shops at West Albany. We hope that this letter will receive the careful attention of all our readers, as it is a striking example of the value of studying machine tools to obtain the utmost capacity. This statement is vouched for by Mr. C. H. Quereau, superintendent of the West Albany shops. Can any of our readers show such a record as this?—Editor.

To the Editor:

In view of your interest in the matter, I wish to submit the following facts as to the boring of driving tires on an 84-in. boring mill. The figures which I furnish you are actual details of what I am doing every working day.

It must be understood that to accomplish the following results several vital points must be strictly adhered to.

In the first place, the operator must thoroughly understand his machine; he must know what speed to use to get the limit of work from his tools and at the same time keep within the limit of the working power of his machine, so as not to strip any gears, which is very easily done.

This matter of gearing on the large modern boring mills is one which is attracting attention from all users of this class of machine. The driving gears should be more massive—the teeth should be heavier. This applies alike to the cone gears and to those which are underneath the table. This, in my opinion, is absolutely necessary in view of the increased output of these machines since the introduction of the new high-speed tool steels. Speed is *not* an absolutely necessary factor, as these machines will waste power in speed, when they need it to drive the heavy feeds which are used to do the work hereinafter stated. Also the worm and worm gear which operate the friction head on the ram should be made larger and heavier, as this is, in my opinion from personal experience, the weakest point about these machines.

It is "up to" the manufacturer to build machines to suit the tools which are used to-day. The tool steel manufacturers are far ahead of the machine tool builders. When a worm or worm gear gives out (which is a common occurrence) it is necessary to take the whole carriage and ram down off the cross-rail, which is a very long and tedious operation, costing considerable time and expense. This could be entirely done away with if the designer would put two holes through the back of the rail casting, instead of half way through the casting, as at present. The hole should be twice the size of the gear—say, a 10-in. hole where a 5-in. gear is used, and so on in proportion.

I will now give the time taken to bore the following sizes of tires:

Thirty-nine-in. driving tires are put on the machine, set, bored and taken off in 24 minutes; 24 of these are bored in 9½ hours.

Firty-four-in. tires are put on, set, bored and removed in 23 minutes, and occasionally better, as 25 of this size are bored in 9½ hours.

Fifty-in. tires are finished in the same time as 44-in. tires.

Fifty-six-in. and 57-in. tires are bored, set and removed in 21 and 22 minutes. We average 27 of this size in 9 hours. I have bored 28 of this size in 7½ hours.

Sixty-two-in. retaining-ring tires are set, bored, grooved on both sides and taken off the machine in 2½ hours.

Sixty-three-in. retaining-ring tires are set, bored, grooved on both sides and taken off in 2¾ hours.

Sixty-eight-in., 71-in. and 72-in. retaining-ring tires are set, bored, grooved on both sides and removed in 3½ hours.

These times are very often bettered, which decreases a little on the time of boring.

To keep up this service the operator must have four or five helpers. When I have finished a tire it is taken off by two helpers and another which is being held within 10 ft., by two others, is dropped on this one and hoisted on the machine. This keeps four men busy taking the finished work away and keeping rough work ready. The helpers come to my machine when the cut is almost through the tire, so in this way no time is lost. We have eight or ten rough tires standing along the wall within 100 ft. so that we have our stock close to us. The helpers roll these in from the stock of tires outside the shop in the interval between the removal of a finished tire and the boring of the following one.

A shop using these modern machine tools should be very careful to keep plenty of helpers, as the increased output depends to no small degree on the help furnished to their skilled help. I manage to keep four men continually "on the jump" from 7 A. M. to 5 P. M. Their time is constantly used, so that there is no loss from their services. This work is performed in machine shop No. 1, locomotive department, New York Central & Hudson River Railroad, at West Albany, N. Y.

Hoping that this will prove of interest to your readers, I respectfully submit the same.

Albert H. Reese,
No. 19 North Lexington Avenue,
Albany, N. Y.

ENGINEER MAKES FIFTY DOLLARS A MINUTE.

There is a little story connected with the record-breaking run of the Lowe special over the Sante Fe, Chicago to Los Angeles, in less than 53 hours, which is not generally known.

It is related that Mr. Lowe offered the engineer who hauled the train from San Bernardino to Los Angeles—on the home-stretch of sixty miles—the sum of fifty dollars a minute for every minute gained over the schedule. Engineer Warboy turned the wheels at a fifty-second clip for each mile to Pasadena, but had to slow down in the suburbs of Los Angeles. He pulled into La Grande station, Los Angeles, just sixty-two minutes after leaving San Bernardino, gaining nine minutes on the whirlwind schedule and thereby earning $450 extra pin money.

The Sante Fe passenger department will soon publish a pamphlet giving full details of the swift flight of the Lowe special, which in several instances exceeded ninety miles an hour. An average of nearly 43 miles an hour was maintained, in the face of having to cross four high ranges of the Rockies, and with little previous selection of engines or crews.

KNEW ALL BUT ONE THING.

The professor of mechanics at an English college once gave a lecture upon the locomotive, and was particularly struck by the absorption of one juvenile listener. He spoke to the student after the lecture, and asked him:

"Well, I suppose you understand all about the locomotive now?"

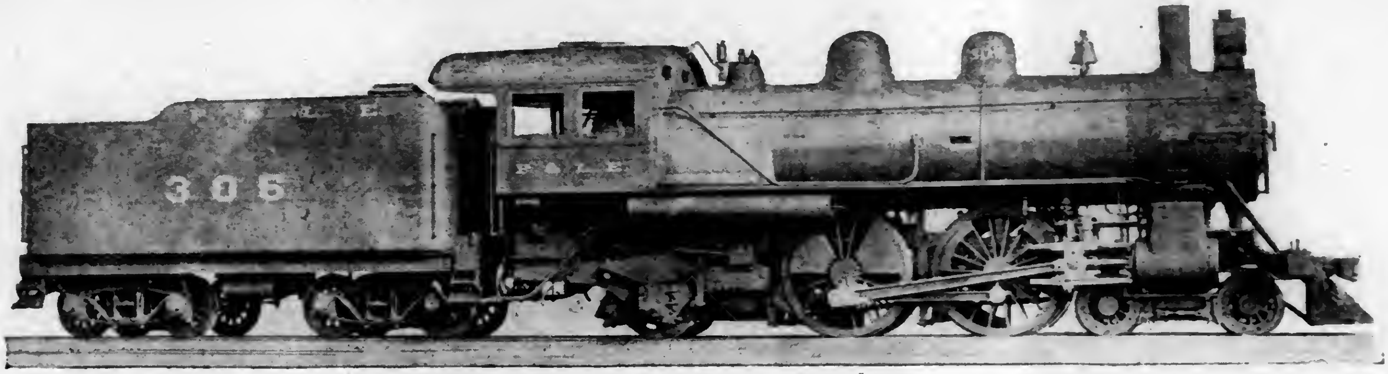
"Yes," was the reply, "all but one thing."

"And what is that?" said the professor kindly.

"I can't make out what makes the locomotive move without horses."

The Gold Car Heating and Lighting Company announce the fact of the decision of the Privy Council of England that the Gold steam hose coupler does not infringe on the Consolidated Car Heating Company's (Sewall) patent. This case was decided against the Consolidated Company in the Canadian courts and was appealed by them to the higher court of England, where the final decision was rendered in favor of the Gold Company. This long and expensive litigation, therefore, has resulted in a victory for the Gold Company.

Steam turbines have entered the field of marine propulsion with a vigor, which promises a revolution in this practice. Three new turbine steamers are now under construction for English Channel service and a new long distance ship of 18 knots is building for service between Great Britain and New Zealand. If this ship is as successful as the earlier turbine steamers, it will be but a short step to the application of turbines to trans-Atlantic service, and this will settle the question of general adoption.



NEW PASSENGER LOCOMOTIVE.—PITTSBURGH & LAKE ERIE RAILROAD 4-4-2 TYPE.

L. H. TURNER, SUPERINTENDENT OF MOTIVE POWER. AMERICAN LOCOMOTIVE CO., SCHENECTADY WORKS, BUILDERS.

NEW PASSENGER LOCOMOTIVES. PITTSBURG AND LAKE ERIE RAILROAD.

4—4—2 TYPE.

This road has received five passenger locomotives from the Schenectady Works of the American Locomotive Company, of which the general appearance is shown in the accompanying engraving. These engines are equipped with the Davis counterbalance and with Allen-American balanced slide valves. A notable feature is the very large tender, having a capacity of 8,400 gals. The water spaces around the firebox are unusually wide, being 4½ and 5 ins. all around. There seems to be a tendency toward increasing the spaces for water around the firebox, which is a commendable improvement. Ratios and the leading dimensions are given in the following tables:

Ratios.

Heating surface to cylinder volume	= 3.11
Tractive weight to heating surface	= 32.64
Tractive weight to tractive effort	= 3.9
Tractive effort to heating surface	= 83.6
Heating surface to grate area	= 63.9
Tractive effort × diameter drivers to heating surface	= 602.
Heating surface to tractive effort	= 11.9%
Total weight to heating surface	= 57.12

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	168,000 lbs.
Weight on drivers	96,000 lbs.
Weight engine and tender in working order	313,000 lbs.
Wheel base, driving	7 ft.
Wheel base, rigid	7 ft.
Wheel base, total	26 ft. 11 ins.
Wheel base, total, engine and tender	56 ft. 11½ ins.

Cylinders.

Diameter of cylinders	20 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5¼ ins.
Diameter of piston rod	3¾ ins.
Size of steam ports	18 x 1⅝ ins.
Size of exhaust ports	18 x 3 ins.
Size of bridges	1⅝ ins.

Valves.

Kind of slide valves	Allen American
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1⅛ ins.
Lead of valves in full gear.	Line and line ford. ¼-in. lead at 6-in. cut-off

Wheels, Etc.

Diameter of driving wheels outside of tire	72 ins.
Thickness of tire	3 ins.
Diameter and length of driving journals	9½ ins. diameter x 12 ins.
Diameter and length of main crankpin journals,	Main side, 7 x 4¼ ins., 6 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals,	Front, 4½ ins. diameter x 4 ins.
Engine truck, journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	33 ins.

Boiler.

Style	Straight
Outside diameter of first ring	68⅝ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	11-16, ½ and ¾ in.
Firebox, length inside	102 ins.
Firebox, width	65⅝ ins.
Firebox, depth	Front, 76¼ ins.; back, 62¾ ins.
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, 7-16 in.; tube sheet, ½ in.
Firebox, water space:	4½ and 5 ins. front, 4½ and 5 ins. sides, 4½ and 5 ins. back
Firebox, crown staying	Radial, 1⅛ ins. diameter
Firebox, staybolts	Ulster spec. iron, 1 in. diameter
Tubes, number	330
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft.
Firebrick, supported on	3-in. tubes
Heating surface, tubes	2,750.2 sq. ft.
Heating surface, water tubes	24.41 sq. ft.
Heating surface, firebox	166.85 sq. ft.
Heating surface, total	2,941.46 sq. ft.
Grate surface	46.27 sq. ft.
Exhaust nozzles	4¾, 5 and 5¼ ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	14 ft. 9⅝ ins.

Tender.

Style	U level top
Weight, empty	53,400 lbs.
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	19 ft. 5 ins.
Water capacity	8,400 U. S. gals.
Coal capacity	10 tons

BOOKS.

Earthwork and Its Cost. By Hulbert Powers Gillette. 234 pages. Engineering News Publishing Company, 220 Broadway, New York. 1903. Price $2.

This book of 234 pages takes up, with considerable care, the subject specified by the title. The table of contents well indicates its scope: Earth shrinkage, earth classification, cost of loosening and shoveling, cost of dumping, spreading and rolling, are the subjects of several chapters. The separation of cost into its elements is not new, but the subject is covered much more completely here than in any former single publication at least. The subjects of costs by wheelbarrows and carts, by wagons, by elevating graders and by cars cover good ground, not occupied, apparently, by any previous work of this character. Trenching for pipe laying and sewer construction are touched upon, as are also the cost of hydraulic excavation and of dredging, together with a chapter in miscellaneous cost data. In the appendix there are what are practically short chapters on earthwork computation, and on overhaul diagrams, together with other matters of smaller scope. A very large amount of work has been done in compiling this information and in its arrangement. It is doubtless true that many contractors do not estimate the items of work in sufficient detail, and it goes without saying that many engineers are inefficient in estimating cost. The author, on the other hand, seems a trifle pessimistic and polemic in his views and treatment of affairs in this direction; many engineers are in the habit of separating the items of cost of construction in far greater detail than is indicated in this treatise. It is easy to criticise anything, this book included, but it nevertheless is a desirable contribution to engineering literature, and should prove of value to almost any engineer dealing with construction problems.

Swing Bridges. By "Loidis." Railway Series of Text Books and Manuals by Railway Men for Railway Men. Published by the *Railway Engineer*, 3 Ludgate Circus Buildings, E. C., London, England. Price, 5 shillings.

This little book, which is No. 3 of the Railway Series of Text Books and Manuals by Railway Men for Railway Men, treats of plate girder swing bridges of short spans and gives the computations actually made in the design of several existing structures of this type. It also includes a detailed description of the methods used in operating a number of such bridges, and several modes of computing moments and shears in continuous girders are discussed in the appendices. The author has economized space so thoroughly, however, that it is difficult to follow all his steps; for example, included in the computations are several complicated diagrams, but what they represent is left to the imagination. Except for this defect the book is well written, and on the whole is worthy of being placed in the library of bridge engineers.

MOTOR-DRIVEN MACHINE TOOLS.

INTERESTING APPLICATIONS OF ELECTRIC DRIVING TO MILLING MACHINES.

In no class of machine tools does the application of individual electric driving contribute more to efficient and economical operation than in the case of the milling machine. The nature of the service usually imposed upon the milling machine is so widely variable and embraces such a large range of spindle and feeding mechanism, that it is absolutely impossible to intelligently provide for them beforehand; but in driving with variable-speed motors, in connection with properly selected gearing changes, large speed ranges are made possible with which to obtain to the fullest extent the benefits of modern machine processes and the new high-speed tool steels. Individual driving is rapidly coming into favor for use upon milling machines, for reason of the many advantages to be gained

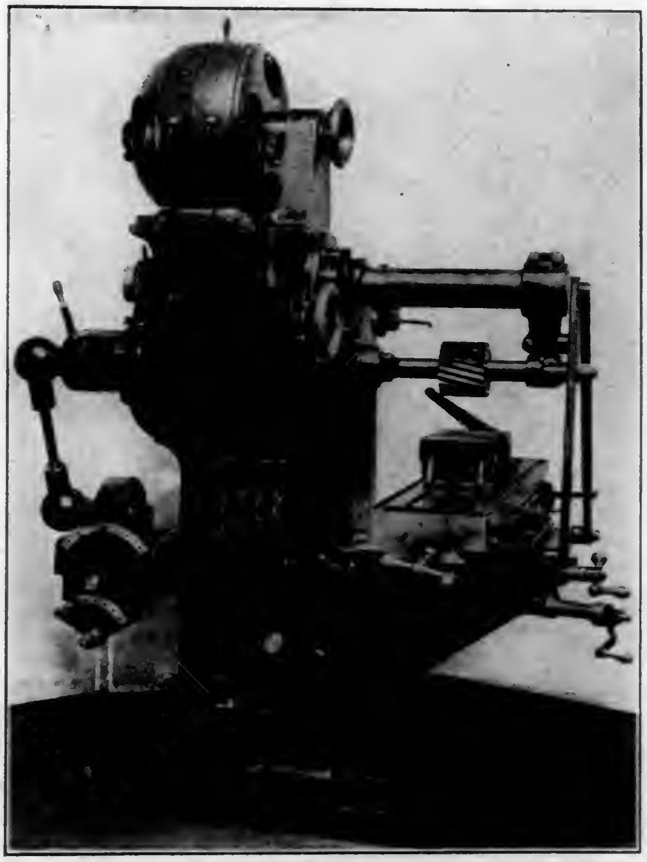


FIG. 1.—VARIABLE-SPEED DRIVE FOR A UNIVERSAL MILLING MACHINE, ALL PARTS ENCLOSED—CINCINNATI MILLING MACHINE COMPANY—CROCKER-WHEELER MOTOR.

thereby, as may be observed from the interesting examples of motor-driving applied to milling machines of some of the foremost and most progressive builders, as illustrated below.

Fig. 1 illustrates a very compact and commendable arrangement of individual electric driving that has recently been applied to the well-known geared-feed milling machine built by the Cincinnati Milling Machine Company, Cincinnati, O., in which a variable-speed form of motor has been used. The drive is furnished by a 7½-h.p. semi-enclosed direct-current motor, built by the Crocker-Wheeler Company, Ampere, N. J., which operates for its speed control upon the 4-wire multiple-voltage system. The speed changes are obtained by means of a 12-point Crocker-Wheeler multiple-voltage controller, which gives six speeds by fundamental voltages and six by resistances, making 12 speeds available in all.

The location of the motor directly over the machine is the most desirable, as it allows the drive for the spindle to be applied to the best advantage—that is between the bearings, without increasing the floor space occupied by the machine. A Morse rocker-joint silent chain is used for the drive instead of a belt, the short distance between centres of the motor shaft and tool spindle making a belt connection almost prohibitive on account of the excessive tension required producing needless waste of power in friction. In its operation the chain is noiseless and positive, and the pull exerted between the shaft and spindle is only that necessary to transmit the power. The sprockets and chain are entirely enclosed in a light, removable cast-iron casing which protects the chain and sprockets from chips and dirt, prevents the throwing of oil at high speeds and prevents injury to the operator.

This tool, having been built for taking heavy cuts in iron, is of substantial proportions and required a 7½-h.p. motor. It is provided with a powerful and positive feed-changing mechanism covering an exceptionally wide range, the gear combinations of which may be instantly changed without stopping the machine. There are 16 feeding speeds, all of which are plainly indicated by raised figures immediately over the feed lever.

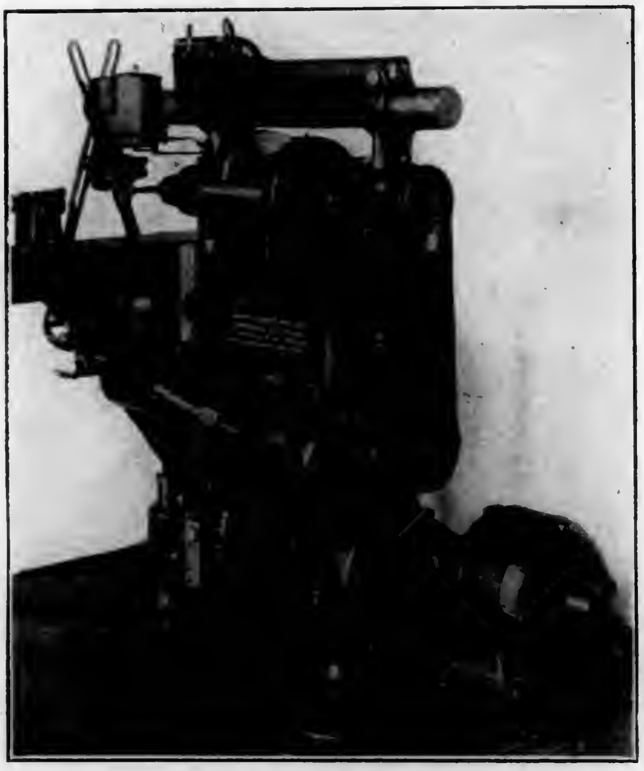


FIG. 2.—CONSTANT-SPEED DRIVE FOR A UNIVERSAL MILLING MACHINE USING CHANGE GEARS FOR SPEED CHANGES—BROWN & SHARPE MFG. CO.—GENERAL ELECTRIC MOTOR.

The table has a 34-inch automatic longitudinal movement and a 9-inch cross and 20-inch vertical hand-operated movement; 36 driving speeds are available, by means of the double back-gear arrangement. There is a 4 to 1 speed reduction with the direct-drive, while with the back-gear in action a 12 to 1 or a 28 to 1 reduction is available. The highest possible speed of the spindle is 278 revolutions per minute and the lowest 14.

The height to the top of the motor is 85 ins. and the floor space required by the machine is 77 ins., back to front, and 106 ins., left to right, to allow the full extent of the longitudinal feed. The hand wheel shown on the extension of the motor shaft beyond the chain casing, is provided in order that, with the current cut off, the motor may be rotated by hand sufficiently to permit the teeth to intermesh when changing the back-gear combinations. It will be noticed that the web of the wheel is made solid to eliminate the chance of catching the fingers of any one working about the motor while it is running. This same element of precaution to protect the workman will be recognized as an excellent feature that is extended to the

entire machine, all gears and moving parts being carefully enclosed.

The arrangement of driving illustrated in Fig. 2 is an exceedingly interesting application on account of its compactness, as well as neatness and ease of handling. The milling machine shown in this case is the No. 3 universal milling machine, built by the Brown & Sharpe Manufacturing Company, Providence, R. I., one of which was equipped as shown for use in the machine shops at the Mare Island Navy Yard. The drive is from a 2-h.p. alternating-current 3-phase induction motor, built by the General Electric Company, to operate upon a voltage of 220-volts at a speed of 1,800-rev. per min. Particular attention should be given the neat arrangement of the motor supporting plate; the necessity of casting a projection upon the base of the milling machine has here been obviated by the use of a separate bed-plate for the motor, which is merely lapped over and bolted to the base of the machine; this greatly cheapens the cost of the motor attachment to the machine, as such a motor arrangement is thus applicable to any milling machine by merely bolting on a motor bed-plate.

The spindle is driven from the motor by a silent driving

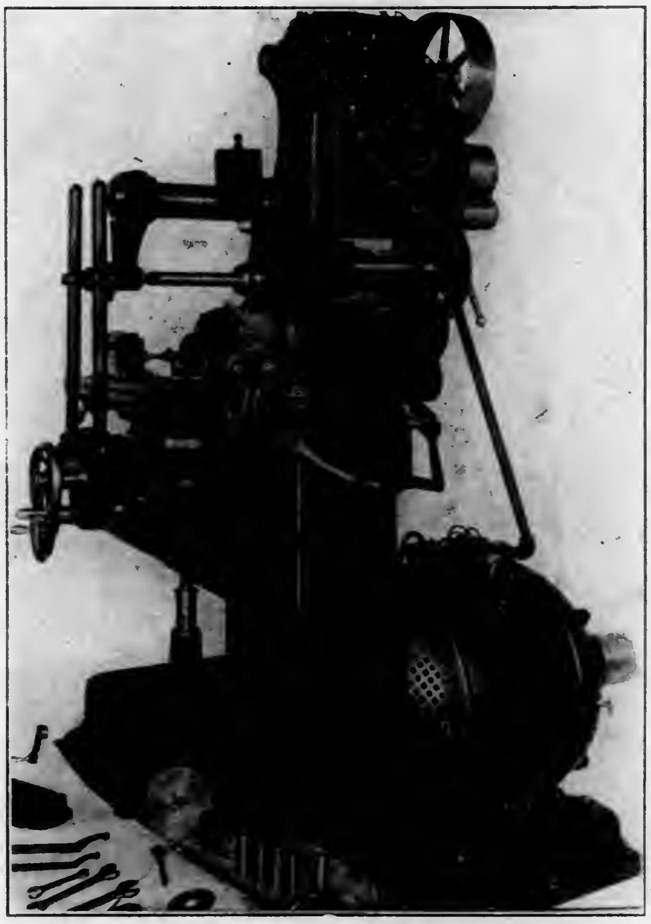


FIG. 3.—CONSTANT-SPEED DRIVE BECKER-BRAINARD UNIVERSAL MILLING MACHINE WITH CONE PULLEYS—STURTEVANT MOTORS.

chain, in the gear case shown, and then through change gearing to another chain running on a sprocket directly on the spindle of the machine. The change gearing device in the base of the machine for varying spindle speeds is unusually simple and efficient. The changes are made by the simple adjustment of the lever and a sliding knob shown on the plate at bottom of machine. To obtain any required spindle speed the lever is first unlatched and dropped down as far as it will go; the sliding knob is then moved along until it is over the column in the speed plate containing the required speed. The lever is then unlatched and moved up as far as it will go, when the latch will drop into the proper hole and the gearing is properly meshed for the speed. One great advantage of this form of construction is that it enables the use of any standard constant-speed motor, by the use of which the full capacity of the motor is at all times available. The feeding mechanism is driven directly from the main spindle by a chain and sprocket wheels, as is clearly shown in the engraving, Fig. 2.

Fig. 3 presents a view of an interesting constant-speed drive for this type of machinery. This tool is the No. 2 new model of universal milling machine, built by the Becker-Brainard Milling Machine Co., one of which was thus arranged for the U. S. Government for use on shipboard. The motor used is a Sturtevant variable-speed motor, and is mounted upon an extension bed-plate, to which the milling machine is bolted. The drive is in this case by belt to a small counter-shaft, which is mounted above the machine's column by brackets, as shown. This counter-shaft carries a cone pulley to correspond with the spindle cone. Six changes of speed are available from the motor, so that, with the 4 cone changes and the back gear, 48 spindle speeds are afforded.

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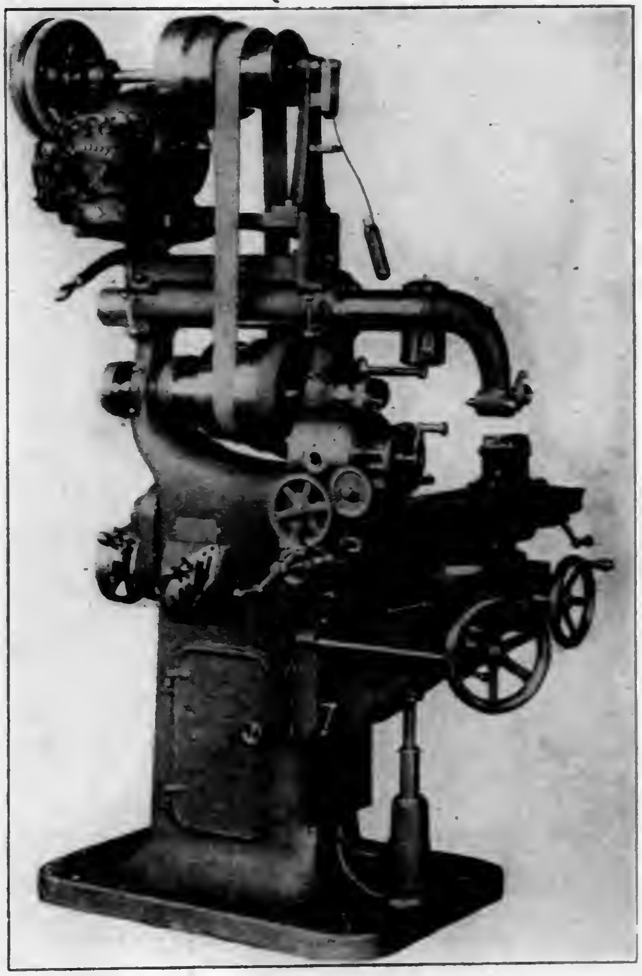

FIG. 4.—CONSTANT-SPEED DRIVE HENDY-NORTON UNIVERSAL MILLING MACHINE WITH BOTH CHANGE GEARS AND CONE PULLEYS NORTHERN ELECTRIC MOTOR.

Brainard Company. The gear combinations in the feed box permit of 20 changes of feeding speed for each spindle speed, which, by virtue of the easiness of changing, enables this machine to meet every possible demand for universal milling work.

A noticeable feature of this motor application is the arrangement of the wiring. The main switch and starting box are safely mounted upon the rear of the column out of the way of harm and yet within easy reach at all times. The wires are carried down to the motor in an iron pipe conduit for safeguard—this is a point too often overlooked. This arrange-

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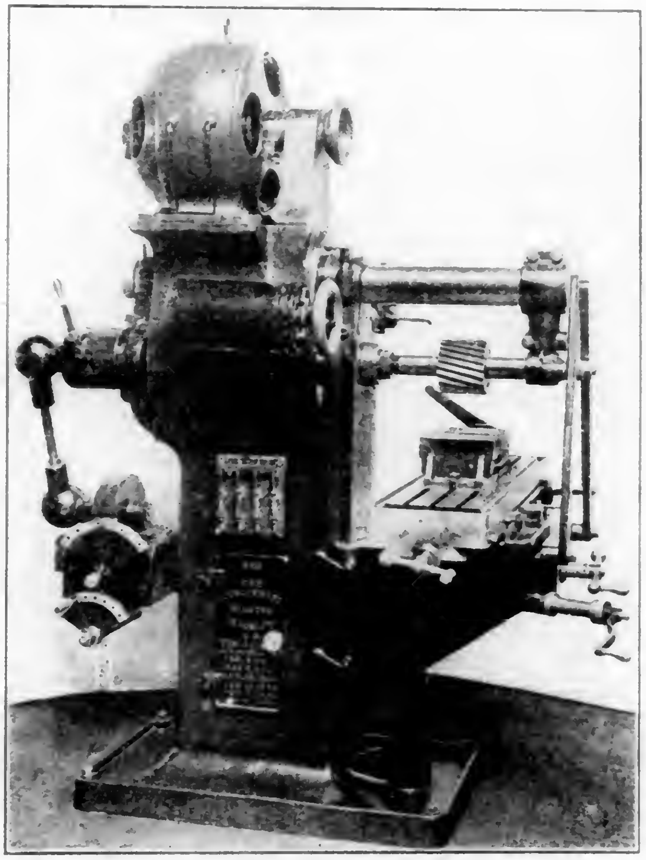

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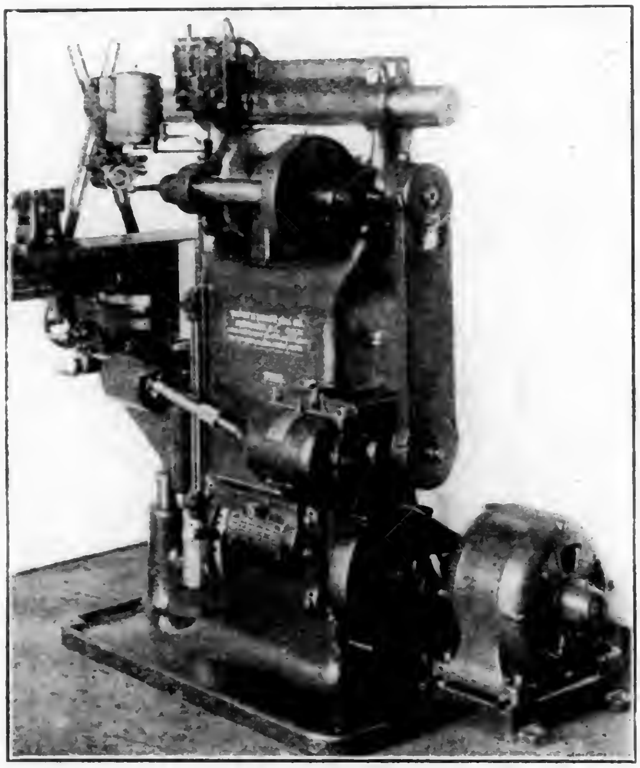

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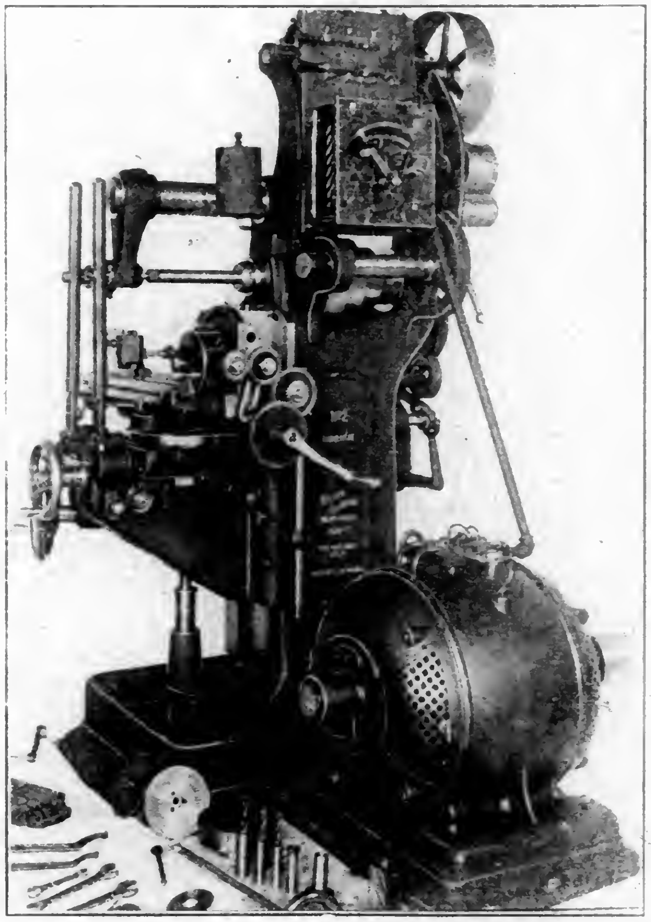

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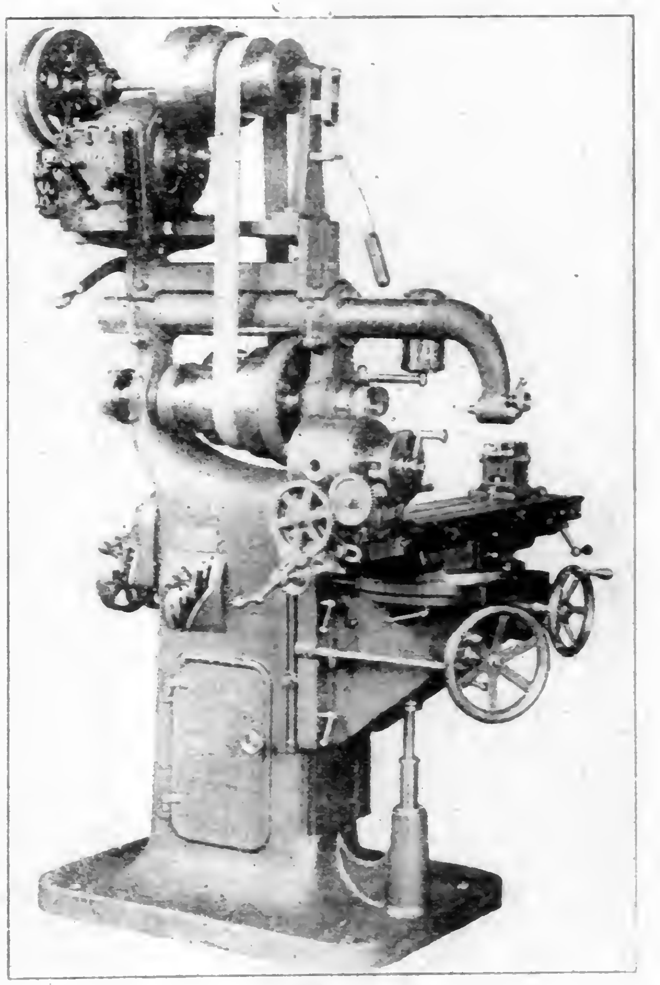

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A noticeable feature of this motor application is the arrangement of the wiring. The main switch and starting box are safely mounted upon the rear of the column out of the way of harm and yet within easy reach at all times. The wires are carried down to the motor in an iron pipe conduit for safeguard—this is a point too often overlooked. This arrange-

ment merits careful consideration for the many commendable features.

The motor drive upon the milling machine illustrated in Fig. 4 is probably unrivalled for compactness in the class of drives retaining the cone pulleys and belts. This machine is the No. 2 universal milling machine, built by the Hendey Machine Company., Torrington, Conn., which is well known for the interesting Norton system of mounted gearing that has been applied to its feeds (as described on page 373 of our October issue), as well as its many other labor-saving features. The motor used upon this miller (the No. 2), is a 1-h.p. enclosed direct-current motor, built by the Northern Electrical Manufacturing Company, Madison, Wis. For their larger size (the No. 3) miller, the Hendey Company apply a 2-h.p. motor for driving.

Economy of floor space is secured in this drive by mounting the motor on a substantial bracket fastened directly to the solid housings of the milling machine. The armature shaft of the motor carries two rawhide pinions of different diameters meshing into the two large gears on the back gear shaft, which carries the upper cone pulley. This gearing is properly proportioned to give the required speeds to the back-geared shaft, performing in full functions of the two-speed counter-shaft drive.

The large gears run freely on their shaft and their inner surfaces are formed like friction pulleys, between which and keyed to but sliding on the shaft, is the familiar type of friction cluthch; this is thrust into connection with either gear as desired by the upper shipper rod running through the hollow back-gear shaft, and operated by the lever shown at the front of the bracket. All the desired changes of speeds are thus transmitted to the spindle of the milling machine, although still allowing the motor to run at a constant speed, maintaining at all times its maximum efficiency.

The upper half of the bracket carrying the motor has a short vertical movement in its base, controlled by a cam shaft operated by the lever shown under the starting box. In order to shift the driving belt from one step of the cone to another the motor bracket is lowered by the cam shaft, thus relieving the tension on the belt, and after the belt is changed it is quickly tightened by the same means, and the bracket is locked in place.

An interesting arrangement of driving is shown in Fig. 5, upon a milling machine of the horizontal or planer type. This tool is the No. 6 slab milling machine, built by Bement, Miles & Co., Philadelphia, Pa., which was recently equipped in this manner for the Altoona shops of the Pennsylvania Railroad. It is a large tool, having a distance between uprights of 37½ ins. and a maximum distance of the spindle centre above the table of 30 ins., and is intended for the heaviest classes of service.

The drive is particularly interesting in that 3 motors are used, one for the spindle, one for the feeds and the third for elevating the crossrail. The main motor, operating the spindle drive, is a 25-h.p. direct-current motor, operating at variable-speeds by field control; this motor is not visible in the view, being located behind the tool. The table feed motor is a 5-h.p. direct-current machine, shown at the right, behind the gearing box. This motor operates at variable-speeds by field control, and also is assisted in varying the speeds by the gear box shown in front of it; this permits a very wide range of table feeds to accommodate all classes of service. The crossrail is elevated and lowered by a 3-h.p. constant-speed direct-current motor located on the top of the uprights, as shown. All three of the motors used in this equipment are standard direct-current motors, built by the General Electric Company, Schenectady, N. Y.

HOW OLD IS THE DUTCH ENGINE?

An English engine is 24 years old. The English engine is twice as old as the Dutch engine was when the English engine was as old as the Dutch engine is now. How old is the Dutch engine?

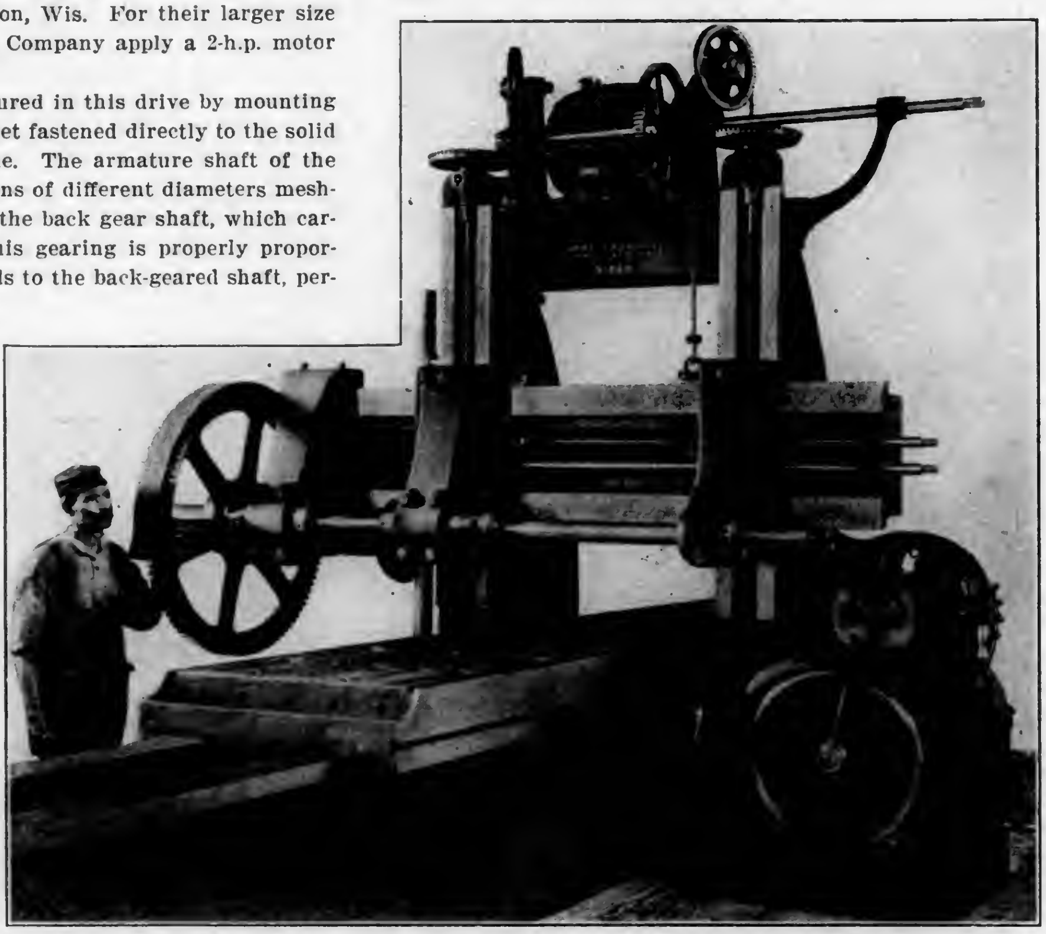

FIG. 5.—COMPLEX-DRIVE FOR A BEMENT-MILES SLAB MILLING MACHINE. WITH SEPARATE MOTORS FOR SPINDLE, TABLE FEEDS AND ELEVATING CROSS RAIL. GENERAL ELECTRIC MOTORS.

TESTS OF HOLLOW STAYBOLTS.

Among a number of records of tests of hollow staybolts, made at the testing laboratories of McGill University, the following are selected as being a representative of the material, when tested in the solid and hollow form:

M'GILL UNIVERSITY TESTING LABORATORIES, MONTREAL, CANADA.

Report of results of tensile test of one specimen of solid staybolt iron from the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, U. S. A. For Mr. John Livingstone, Montreal, Canada.

SPECIMEN—SOLID.

Dimensions	1 in.
Yield point in lbs. per sq. in.	33,790
Ultimate strength in lbs. per sq. in.	50,150
Per cent. of elongation in 8 ins.	29.25
Per cent. of reduction of area	56.44

SPECIMEN—HOLLOW, 1 IN. x 3-16 IN.

Dimensions in inches	1 in.
Yield point in lbs. per sq. in.	27,520
Ultimate strength in lbs. per sq. in.	48,420
Per cent of elongation in 8 ins.	32.5
Per cent. of reduction of area	53.7

Mr. R. H. Soule has opened an office in the Astor Court Building, 20 West 34th street, New York. His friends will all rejoice with us that he is restored to health and ready for active work again. He will continue his consulting engineering practice, which he has not entirely dropped during his long illness.

A NEW DESIGN OF MOTOR DRIVING FOR A TRAVERSE SHAPER.

CINCINNATI SHAPER COMPANY.

The accompanying engraving illustrates a novel arrangement of motor driving that has been applied to an 18-inch by 14-foot double-head traverse shaper, recently built by the Cincinnati Shaper Co., Cincinnati, O., for the new works of the Locomotive and Machine Co. of Montreal, Canada. An arrangement for independently driving each shaper head at any point upon the bed, with a movable bearing support for the two splined driving shafts, is used, which involves interesting and novel features.

Two motors are used, as is usual upon traverse shapers of this type, one being used for the independent drive of each head. The motors are the new Westinghouse type-S variable-speed direct-current motors, operating upon the ordinary three-wire system, and are rated at a capacity of 3 and 6 h.p. with the two standard voltages of 115 and 230 volts, respectively. The drive is, in each case, direct through a large gearing reduction to the splined driving shaft at the rear of the bed, from which shaft the drive for the traversing shaper head is taken. In addition to the variations of speed furnished by the motor speed-control system, another run of speeds is provided for by the usual back gear attachment, which is located, as shown, alongside of the large gear wheel upon the end of the splined shaft.

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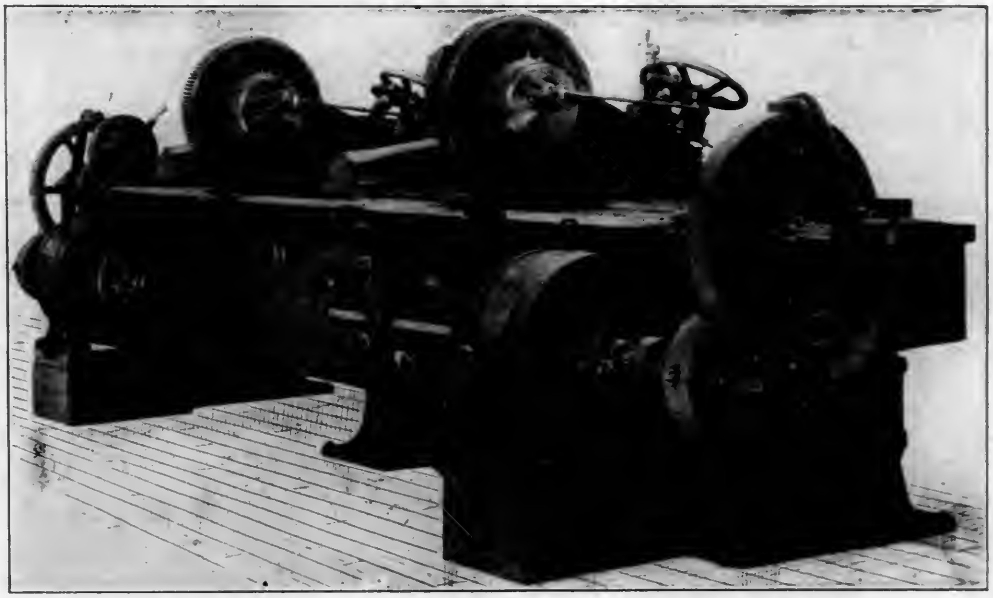

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15	Marcinelle	1898-99	1,088,603	2,343	464
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10	Haine St. Pierre....	1899	611,416	3,405	179
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ment merits careful consideration for the many commendable features.

The motor drive upon the milling machine illustrated in Fig. 4 is probably unrivalled for compactness in the class of drives retaining the cone pulleys and belts. This machine is the No. 2 universal milling machine, built by the Hendey Machine Company., Torrington, Conn., which is well known for the interesting Norton system of mounted gearing that has been applied to its feeds (as described on page 373 of our October issue), as well as its many other labor-saving features. The motor used upon this miller (the No. 2), is a 1-h.p. enclosed direct-current motor, built by the Northern Electrical Manufacturing Company, Madison, Wis. For their larger size (the No. 3) miller, the Hendey Company apply a 2-h.p. motor for driving.

Economy of floor space is secured in this drive by mounting the motor on a substantial bracket fastened directly to the solid housings of the milling machine. The armature shaft of the motor carries two rawhide pinions of different diameters meshing into the two large gears on the back gear shaft, which carries the upper cone pulley. This gearing is properly proportioned to give the required speeds to the back-geared shaft, performing in full functions of the two-speed counter-shaft drive.

The large gears run freely on their shaft and their inner surfaces are formed like friction pulleys, between which and keyed to but sliding on the shaft, is the familiar type of friction cluthch; this is thrust into connection with either gear as desired by the upper shipper rod running through the hollow back-gear shaft, and operated by the lever shown at the front of the bracket. All the desired changes of speeds are thus transmitted to the spindle of the milling machine, although still allowing the motor to run at a constant speed, maintaining at all times its maximum efficiency.

The upper half of the bracket carrying the motor has a short vertical movement in its base, controlled by a cam shaft operated by the lever shown under the starting box. In order to shift the driving belt from one step of the cone to another the motor bracket is lowered by the cam shaft, thus relieving the tension on the belt, and after the belt is changed it is quickly tightened by the same means, and the bracket is locked in place.

An interesting arrangement of driving is shown in Fig. 5, upon a milling machine of the horizontal or planer type. This tool is the No. 6 slab milling machine, built by Bement, Miles & Co., Philadelphia, Pa., which was recently equipped in this manner for the Altoona shops of the Pennsylvania Railroad. It is a large tool, having a distance between uprights of 37½ ins. and a maximum distance of the spindle centre above the table of 30 ins., and is intended for the heaviest classes of service.

The drive is particularly interesting in that 3 motors are used, one for the spindle, one for the feeds and the third for elevating the crossrail. The main motor, operating the spindle drive, is a 25-h.p. direct-current motor, operating at variable-speeds by field control; this motor is not visible in the view, being located behind the tool. The table feed motor is a 5-h.p. direct-current machine, shown at the right, behind the gearing box. This motor operates at variable-speeds by field control, and also is assisted in varying the speeds by the gear box shown in front of it; this permits a very wide range of table feeds to accommodate all classes of service. The crossrail is elevated and lowered by a 3-h.p. constant-speed direct-current motor located on the top of the uprights, as shown. All three of the motors used in this equipment are standard direct-current motors, built by the General Electric Company, Schenectady, N. Y.

HOW OLD IS THE DUTCH ENGINE?

An English engine is 24 years old. The English engine is twice as old as the Dutch engine was when the English engine was as old as the Dutch engine is now. How old is the Dutch engine?

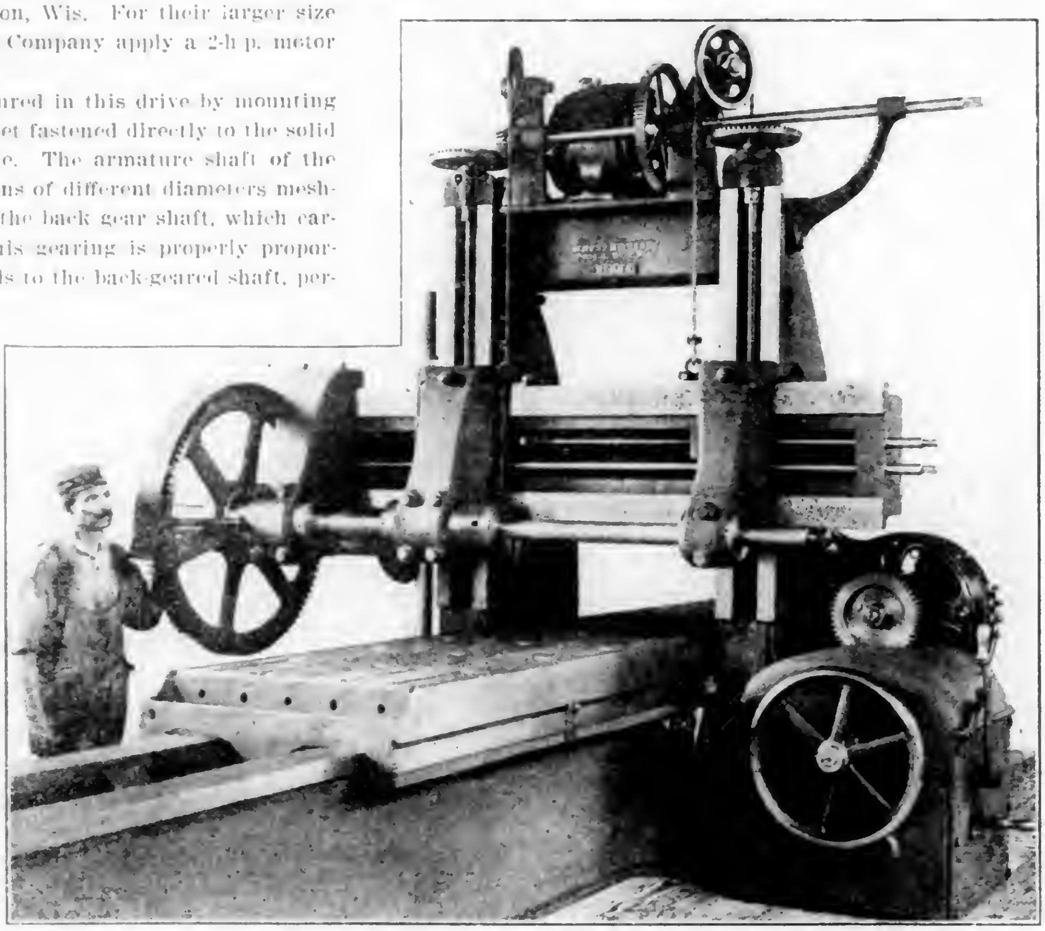

FIG. 5.—COMPLEX-DRIVE FOR A BEMENT-MILES SLAB MILLING MACHINE, WITH SEPARATE MOTORS FOR SPINDLE, TABLE FEEDS AND ELEVATING CROSS RAIL. GENERAL ELECTRIC MOTORS.

TESTS OF HOLLOW STAYBOLTS.

Among a number of records of tests of hollow staybolts, made at the testing laboratories of McGill University, the following are selected as being a representative of the material, when tested in the solid and hollow form:

M'GILL UNIVERSITY TESTING LABORATORIES, MONTREAL, CANADA.

Report of results of tensile test of one specimen of solid staybolt iron from the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, U. S. A. For Mr. John Livingstone, Montreal, Canada.

SPECIMEN—SOLID.

Dimensions	1 in.
Yield point in lbs. per sq. in.	33,790
Ultimate strength in lbs. per sq. in.	50,150
Per cent of elongation in 8 ins.	29.25
Per cent of reduction of area	56.44

SPECIMEN—HOLLOW, 1 IN. x 3-16 IN.

Dimensions in inches	1 in.
Yield point in lbs. per sq. in.	27,520
Ultimate strength in lbs. per sq. in.	48,420
Per cent of elongation in 8 ins.	32.5
Per cent. of reduction of area	53.7

Mr. R. H. Soule has opened an office in the Astor Court Building, 20 West 34th street, New York. His friends will all rejoice with us that he is restored to health and ready for active work again. He will continue his consulting engineering practice, which he has not entirely dropped during his long illness.

A NEW DESIGN OF MOTOR DRIVING FOR A TRAVERSE SHAPER.

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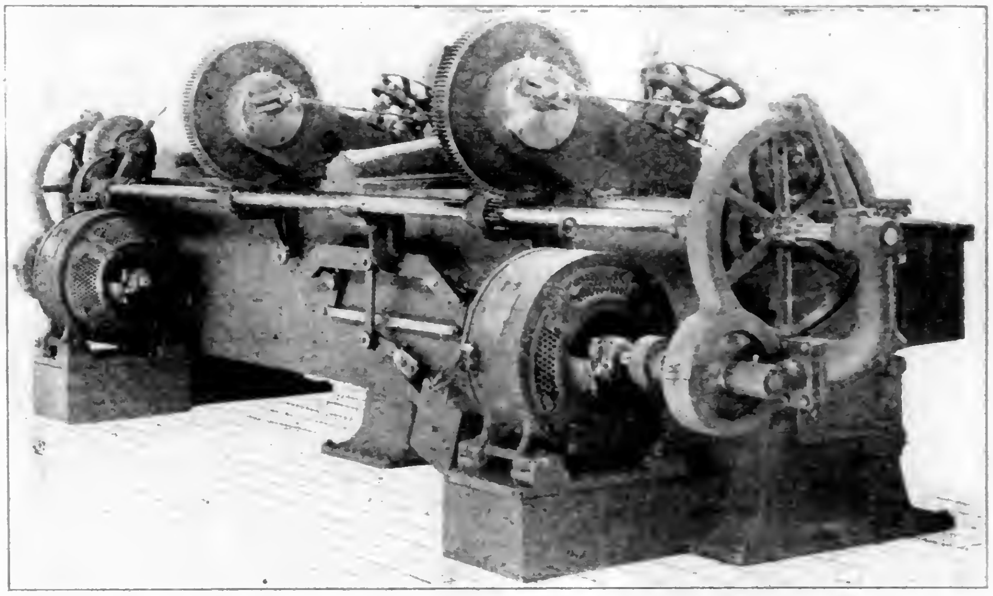

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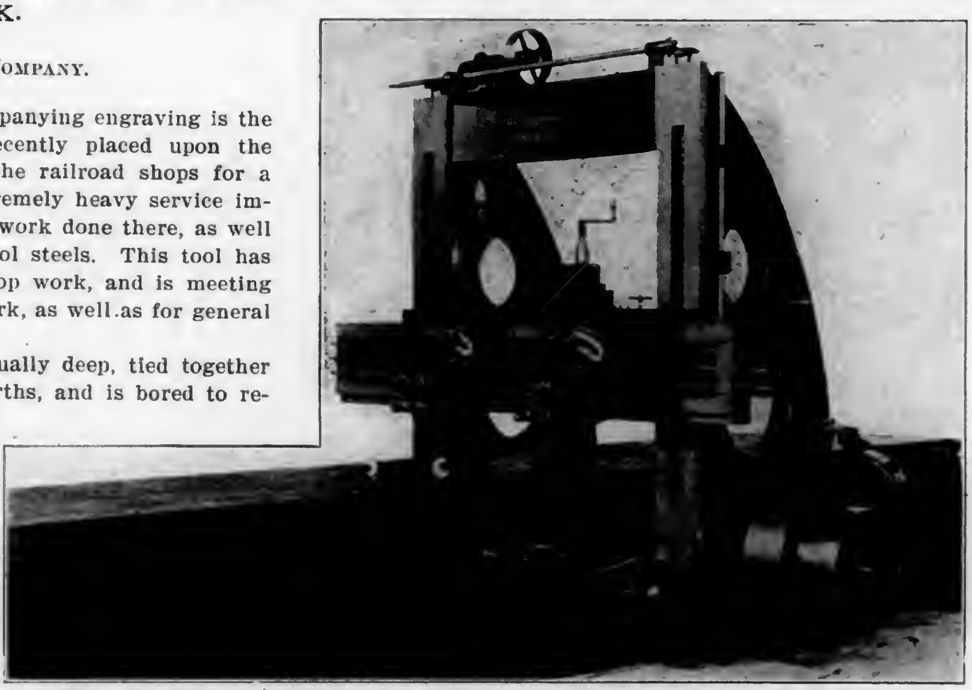
miles with 7,423 stays replaced, or one stay for 2,459 miles. A study of these records brought to light facts which merited the highest consideration, in order to find satisfactory reasons for results so widely different between the British and the American boiler, each typical in design and manufacture of the country of its origin. Very varied results in boilers constructed to the same drawings, conditions and inspection, but by different manufacturers, had also been experienced. The excellent result of the Baldwin boiler must, he thought, be attributed to the fact that only one metal was used in constructing its various parts; the coefficient of expansion and contraction was obviated. Such remarkable results would, he thought, be a surprise to many, and would lead engineers to consider seriously the advisability of the use of one metal only in the construction of boilers. The cause of so varied a life of firebox stays in boilers in similar design, construction and inspection, and which apparently had been worked and attended to under similar conditions, must be sought for in the quality of the metal used. He could not account for it any other way.

AN IMPROVED HEAVY-DUTY PLANER] FOR RAILROAD WORK.

Cincinnati Planer Company.

The planer illustrated in the accompanying engraving is the improved 48-in. planer that was recently placed upon the market to meet the demand from the railroad shops for a tool capable of withstanding the extremely heavy service imposed by the heavy character of the work done there, as well as the use of the new high-speed tool steels. This tool has much to commend it for railroad shop work, and is meeting with approval for switch and frog work, as well as for general machining.

The bed of this tool is made unusually deep, tied together at short intervals by extra heavy girths, and is bored to receive the bushings for the various bearings. All the gearing and the rack are made of steel and are placed on the inside of the bed, so as to be thoroughly protected by the special covers from cuttings or dirt falling into same. The table is extra heavy, and is braced throughout by heavy ribs. Long steel gibs on each side prevent the table from lifting when extra heavy cuts are taken.



HEAVY 48 X 48-INCH PLANER FOR FROG, SWITCH AND GENERAL RAILROAD SHOP WORK.—CINCINNATI PLANER COMPANY.

The rail is very deep, and has an extra deep box brace on the back to give additional stiffness. The saddle has almost double the usual length of bearing on the rail, as may be seen in the illustration. The overhanging ledge on the back of the saddle is cast solid, and wear is taken up by the gib on the top and back, thus preventing the spring that might occur if this rear clamp were bolted on. The saddles are made right and left, so that the heads can be brought very close together. The pulleys are made extra wide to transmit additional power and also prevent the necessity of keeping the belts unusually tight to perform their work.

In addition to these special features, this tool has all of the prominent features of the planers made by this concern, such as the micrometer adjustment on the down feed screw, and the dirt-proof table, which prevents cuttings or dirt getting into the ways, yet allowing all holes to be drilled clear through the table. A safety locking device is also provided, which prevents the table from starting except at the will of the operator, and a combination friction feed mechanism which insures a steady feed at all times.

A Swiss engineer, Mr. Thorman, has made a report upon the advisibility of equipping all of the railway lines of that country for electric traction. The increased cost of coal, during the past few years and availability of water power render this idea attractive.

THE "FRONT END" QUESTION BEFORE THE TRAVELING ENGINEERS.

In the discussion of the subject of locomotive draft appliances before the Traveling Engineers' Association at its recent convention in Chicago, the usual variety of opinion as to the best arrangement was exhibited. Those who have followed the record of recent investigation of this subject in this journal are not surprised by the conclusion reached by this association to the effect that it is not advisable at this time to attempt to make definite and positive recommendations. The traveling engineer is in closest touch with the difficulties connected with this problem, and the action of the association is commendable and pleasing to those who are endeavoring to throw light on the proper way to overcome the difficulties. The association passed the following resolution, and this expression of a desire to assist in the work gives promise of valuable co-operation:

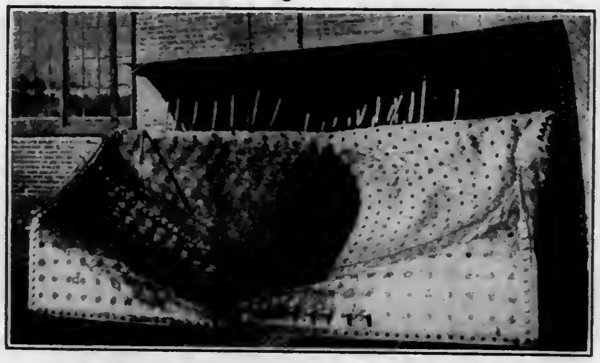
"Resolved, That we, the Traveling Engineers' Association, recommended no special or definite front-end arrangement at this time, but do recommend that the facts developed by the Master Mechanics' Association and by Professor Goss, of Purdue University, be made our basis for future work and research; and further, we believe the greater part of the difficulties experienced in service are due more to lack of system in keeping the appliances adjusted so as to give the best results than to the mechanism itself."

To know what investments will pay and what will not in the matter of supplying facilities for rapid work at outlying or relatively small shops is sometimes a difficult question, and an important one. If shops are too small to justify the expense of traveling cranes the tendency is to get along with poor facilities, or none at all, for handling driving wheels. In our next issue will be shown a well designed drop pit which is now in use at the Sheridan, Wyo., shops of the Burlington & Missouri River Railroad. It illustrates a simple and relatively inexpensive method of handling this important work. This sort of equipment must necessarily bring good returns on the investment, particularly, as in this case, when the drop pit is so conveniently arranged with reference to the machine work on wheels. It is fully as necessary to plan for convenience in small plants as in large ones, and in this case we have an example which might with advantage be applied to many old shops which are now seriously inconvenienced by lack of facilities of this character.

A REMARKABLE LOCOMOTIVE BOILER EXPLOSION.

In this interesting explosion every staybolt pulled through the crown sheet and not a single broken bolt was found. The superintendent of motive power of the road on which the accident occurred described it as follows:

"This engine, which was one of our wide firebox consolidation engines, had recently received a new firebox and had been running about a month. The engineer in charge was under the influence of liquor at the time of the explosion and, as usual in such cases, he received no injury whatever. The escaping steam blew the fire out of the firebox door and the steam and fire burned the fireman quite badly. The nine rows of staybolts in the crown sheet were screwed through the sheet and a nut with a copper washer between the nut and the sheet on the fire side. The sheet was so hot that the nuts were stripped off the bolts and the bolts pulled through the sheets. There was not a single bolt broken in the explosion, nor was there a broken bolt to be found in the firebox anywhere. The sheet made a reverse curve before it separated after having been stripped off the bolts, and both edges of the sheets were drawn down to a knife blade edge, showing how hot the sheet must have been and the tenacity of the metal. The outer shell of the firebox on the engineer's side was bulged at least 4 ins. at the center, and the strangest part of the whole explosion, in my mind, was the fact that directly over the crown of the firebox the outer shell was lapped. When these



FROM A PHOTOGRAPH OF THE FIREBOX.

engines were built it was necessary to use two sheets in forming the shell over the firebox; notwithstanding the single sheet was bulged on the right hand, or engineer's side, at least 4 ins. in the center, this double thickness was pulled down the center so that it was depressed at least 4 ins. This was the interesting part of the explosion, which I hoped could be shown on a photograph, but we could not make it show as it actually appeared."

ECONOMIZERS IN POWER STATIONS.

Mr. Edwin B. Katte in a paper read last month before the New York Railroad Club, presented the subject of economizers in a new way. He selected conditions representing an extreme case which was not favorable to the use of this apparatus, but which represented actual conditions of a large power station having 19,200 boiler horse-power with a small average load, and from his assumptions showed that, considered as an investment, a gain of only $200 per year would be had from the operation of this apparatus. In summing up the conclusions of his discussion, the author stated the advantages to be had from economizers in this case to consist of a small saving in operating expense, less wear and tear on boilers, due to higher feedwater temperature; a large storage of hot water to care for a sudden increase of load and the advantage to be gained because of the fact that a large proportion of the impurities in the water would be thrown down in the economizer in the form of soft mud and upon surfaces which were not subjected to high temperatures and could be easily cleaned. The disadvantages of economizers were the additional complication of the plant by use of apparatus which might get out of order.

The object of the author of the paper was to draw arguments and information from the manufacturers and users of economizers. As a result, four witnesses for the defense appeared with carefully considered replies in the form of papers. Two were by economizer manufacturers and two by users of large economizer units. At the end of the discussion the matter was left in very much the same condition as represented by Mr. Katte, that is—additional boilers might as well be used in plants having relatively small loads or flat load curves, but with heavy loads and high peaks the economizer is beneficial and offers an opportunity for a material saving.

One of the replies, by Mr. A. H. Blackburn, is an admirable study of economizer arrangement, showing three different plans for meeting the conditions stated by Mr. Katte and presenting net returns of from 4.77 to 32.9 per cent. on the investments, according to the arrangement of the economizer and the average load on the plant. This paper is too long to print in full, and it cannot be presented in abstract.

The reply by Mr. R. D. Tomlinson recorded results of tests upon the economizer installation in the 74th street power house of the Manhattan Elevated in New York, and presented figures showing a net return of 30.5 per cent. on the initial outlay. This was an account of actual service.

Another reply, from Mr. J. E. Moulthrop, of the Edison Electric Illuminating Company, of Boston, together with the author's verbal discussion, indicated that his company does not feel sure whether or not it is advisable to install economizers in their new plant. The importance of simplicity of plant in cases of emergency was strongly presented.

Taken as a whole this discussion brought out more valuable information with respect to this apparatus than has been collected before, although it did not decide the question implied by Mr. Katte in his paper. Those interested should procure copies of the proceedings of the October meeting of the New York Railroad Club, which will record the whole matter.

A PLEA FOR LARGE FIREBOXES.

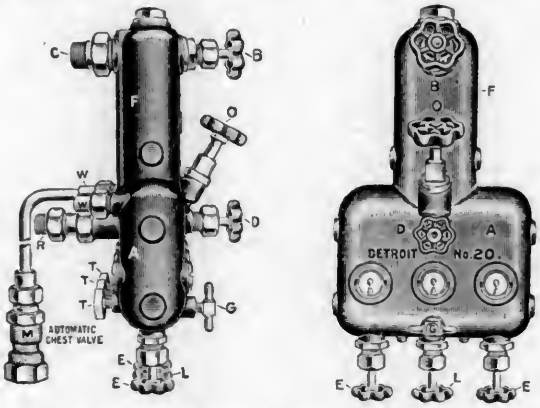
In an admirable paper read last month before the Western Railway Club, Mr. T. S. Reilly, associate editor, *Railway and Engineering Review*, called attention to the fact that while locomotive boilers have greatly increased in size, as to heating surface and grate area, the proportion of firebox to total heating surface had not been maintained. This is urged as an important subject for attention by those who are troubled by firebox leakages and failures. Mr. Reilly presents an exceedingly important suggestion to the effect that fireboxes should be larger. How to make them larger is beyond the scope of the paper. In 1897 the Master Mechanics' Association recommended that the firebox heating surface should be at least 10 per cent. of the total heating surface. With the increase in heating surface and grate area in proportion of 5 per cent. is not now uncommon, and there can be no doubt that boiler troubles have increased since this movement began.

Combustion chambers have had a bad name in the past. On some accounts they are not, and perhaps never will be, strictly satisfactory, but it may be found that a return to this construction will be necessary. At least they will undoubtedly give less trouble than flue sheets do now. Why would it not be a good idea to experiment with combustion chambers in conical boilers with plenty of water space below and beside the combustion chambers? This may prove to be the way out of the present difficulty. One inch bridges between tubes, six inches of space between the boiler shell and the outside tubes, a conical boiler and a combustion chamber, constitutes a combination which is well worth trying in the present emergency.

Mr. J. B. Musgrave, master car builder of the Great Northern Railway of Canada, has resigned.

A NEW TYPE OF LOCOMOTIVE LUBRICATOR.

The Detroit Lubricator Co., of Detroit, Mich., have recently perfected and placed on the market a locomotive lubricator of new design for which many advantages are claimed. The manufacturers have endeavored to get back to first principles and furnish a safe and efficient device in a very simple form. The fact that it has only about half as many parts as the regular type of lubricators will appeal favorably to those who have to look after the cost of maintenance, and as glass discs about



one inch thick are used for the sight feed feature all danger from broken glasses is entirely removed. As it has but very few joints the liability to leakage is slight, and as the oil is delivered to the sight feed chamber from a point within the reservoir there can be no chilling of the oil in cold weather. This lubricator is known as the "Detroit No. 20." The manufacturers will be glad to send descriptive matter to all interested.

DEVELOPMENT OF BRILL TRUCKS.

At the October meeting of the Engineers' Club of Philadelphia, Mr. W. H. Heulings, Jr., read a paper on the "Development of the Brill System of Trucks for Electric Motor Cars."

During the Centennial Exposition several types of steam motor cars were put in use on the streets of Philadelphia. Mr. John A. Brill saw at that time that if cars were to be self-propelled the motors would require a framework separate from that of the car body. The framework of the cars is required to be as light as possible and would therefore be unable to withstand the vibrations and strainings of the motors. Before 1887 some cars had been built with the motors set upon the front platform or hung from the body, but the racking and straining very quickly shook the cars to pieces. The truck was the starting point of the mechanical success of electric motor-driven street cars. Mr. Heulings traced the successive development of the Brill system of truck and stated that the right method of motor support was adopted for the first type of truck and that this method of support is now in universal use. In the earlier forms of truck the use of coil springs resulted in a bounding motion or oscillation of the car body. It was discovered that this oscillation was caused by a rythmic motion in the springs produced by the rail joints, and the difficulty was obviated by introducing, in connection witn the coils, slower acting elliptical springs. Later on the full elliptical springs were superseded by semi-eliptics, which were slower acting. The correct principle in all truck building is to have the frame support the car body as nearly as possible over the points where they are themselves supported. The use of longer car bodies necessitated pivotal trucks, and the maximum traction truck, consisting of a pair of ordinary size driving wheels and a pair of pony wheels, was devised. In this truck the weight is eccentrically distributed so that the large wheels carry nearly all of the load, the pony wheels bearing just enough to enable them to guide on the track. A large part of the paper was devoted to the manufacture of the solid forged side frames, and the lantern slides generally referred to this part of the subject. The completed frame is a very complicated forging.

In the discussion which followed the paper it was stated that the large cars used in Philadelphia weigh about 32,000 lbs., while the heaviest car manufactured at this time is used on interurban railways, such as those of Detroit, and weighs about 86,000 lbs. An interurban car with 36-in. diameter wheels and solid forged truck recently made 10 miles in 8 minutes' running. In answer to an inquiry, Mr. Heulings stated that they had found the best brake shoe to be one of soft gray iron with a piece of wrought iron let into the face.

THE CORRINGTON AIR BRAKE.

After a long period of development the Corrington Air Brake Company is ready with its combined automatic and straight-air apparatus. This system combines these two principles in such a way as to maintain each at all times wholly independent of the other, so that while operating one the other may be brought into action if desired. With this system a new consolidated engineer's valve is substituted for the existing valve on the engine, and no change whatever is required in the car equipments. The new valve simply takes the place of the present engineer's valve or combined automatic and straight air equipment now in use.

The objects of this company are: to provide continuous control of either passenger or freight trains, to make easier and smoother stops with a minimum wear and tear on the equipment and with a minimum expenditure of air; to avoid the parting of trains and place in the hands of the engineer a combined valve whereby he may apply automatic brakes to the entire train and straight air on the engine, with the apparatus so arranged as to permit him to release the automatic brakes on the train and retain straight air on the engine. In double heading the pumps and reservoirs of both engines are available. The engineer of the second engine may release and reapply his brakes independently of the leading engine, in case his tires are heating. Also the brakes may be controlled by the second engineer, permitting the engineer of the leading engine to release his brakes in case of overheating. Furthermore, the brakes may be completely released on the first engine and on the train during the period of recharging the auxiliaries. These features are provided in the consolidated valve without sacrificing any function of the automatic brakes and the triples on the engine and tender are not needed. This system will be described and illustrated in this journal.

SUIT WON BY JOHN A. BRILL.

In the suit brought by John A. Brill against the North Jersey Street Railway Company in the Circuit Court of the United States for the District of New Jersey for an injunction to prevent the use of trucks built by the Peckham Motor Truck and Wheel Company, which, was claimed, infringe patents owned by Mr. Brill, a decision was handed down on August 28, fully sustaining the patents.

The defense of the case was assumed and carried on throughout by the Peckham Company through its own counsel, Duell, McGrath & Warfield; Mr. Brill was represented by Francis Rawle, Edmond Wetmore and Joseph L. Levy. The patents involved were both dated June 27, 1899, which patents cover the system of spring-suspended and semi-elliptic spring equalizers of the Brill center-pivotal trucks, No. 27-G. The Peckham trucks in controversy were those known as No. 14-B-3 and No. 16.

The case was tried before Judge Bradford, District Judge for the District of Delaware, to whom it was especially assigned. The argument lasted four days and the case was thoroughly fought out. The court fully sustained all the claims of both patents that were urged on behalf of the complainant, and awarded a perpetual injunction enjoining the railway company from the use of the trucks and directing an account of profits to be taken.

Mr. J. J. Flynn has been appointed master mechanic of the Louisville & Atlantic, with headquarters at Richmond, Ky., succeeding Mr. Louis Wellisch, resigned.

WESTINGHOUSE STEAM TURBINES FOR PENNSYLVANIA RAILROAD.

An order for three steam turbines of the largest size has recently been placed with the Westinghouse Machine Company, East Pittsburgh, Pa., by Westinghouse, Church, Kerr & Co., acting as engineers and constructors for the Pennsylvania Railroad in connection with the New York terminal equipment. These machines will form the initial installation in the new Long Island power house, on which construction is just beginning, and which will serve the traction in the tunnels for the Hudson and East Rivers and the New York terminal at Thirty-second street and Seventh avenue, and also such part of the Long Island Railroad system as is in process of conversion to electric traction.

The turbines will be of the Westinghouse horizontal short barreled type, mounted upon a single bedplate, resulting in a particularly compact arrangement and great economy of floor space; they will have a capacity of approximately 7,500 electrical horse-power each, and will drive 5,500-kw., 3-phase, alternating current generators operating in parallel. Their overload capacity will be over 11,000 horse-power, and each turbine will be provided with a by-pass automatically controlled by the governor to accommodate abnormal fluctuations in load. This will also permit operation at full load non-condensing.

The turbine equipment will operate under conditions favorable to the attainment of high economy, viz: 200 lbs. steam pressure at the throttle, 28-in. vacuum and 175 degs. F. superheat. The generator will be direct connected to the turbine shaft through a flexible coupling, each section of the unit having two bearings of ample proportions, thus avoiding excessive shaft stresses. The 3-phase winding will deliver current directly to the distribution system at 11,000 volts, no step-up transformers being employed. The machines will be separately excited and will carry full load continuously at 100 per cent. to 80 per cent. power factor, with a rise in temperature of 35 degs. C., or 50 per cent. overload for two hours, with an increase in temperature rise of slightly over 50 per cent. Each turbo unit will thus be capable of delivering 8,250 kw. for reasonable intervals and considerably in excess of this figure during momentary load fluctuations.

The entire equipment will be delivered by July, 1904, one year from the date of contract. It is somewhat significant of the state of the turbine industry that eleven Westinghouse turbines of approximately the same size are under construction for heavy electric railway service, both in this country and abroad.

BOOKS AND PAMPHLETS.

American Railway Master Mechanics' Association. Proceedings of the Thirty-sixth Annual Convention, Held at Saratoga, N. Y., June, 1903. Edited by the Secretary, Mr. Joseph W. Taylor, 667 The Rookery, Chicago, Ill.

This volume is uniform with the publications regularly issued by this important organization and contains the constitution, list of members, established standards of practice of the association and the papers, reports and discussions of the 1903 convention. This volume contains specially valuable records on the subject of electrical equipment of shops in the report on this subject, this being the most important paper of a large number of good ones. This is undoubtedly the most valuable volume brought out by this association for a number of years. It is a credit to the association, to the railroads and to the secretary.

Lathes, Screw Machines, Boring and Turning Mills. By Thomas R. Shaw. 700 pages, profusely illustrated with 425 engravings. 8vo, cloth. 1903. Published by The Scientific Publishing Company, No. 53 New Bailey street, Manchester, England. Price, 15 shillings, net.

This work is a practical treatise of the design and construction of turning machines, including lathes, automatic screw machines, boring and turning mills, and their accessories, the object of the author having been to review in detail the many types of machine tools in use in the metal-working trades, and to present constructive details of the more important mechanisms and devices employed. It was considered the best way to treat this subject to illustrate with examples from actual practice, showing the different mechanisms with surrounding details—pictures often convey what descriptions fail to do. The variety of mechanisms to be found at the present time is endless, but this volume will be of great value to the designer in placing before him the best of the practice that has been settled upon by experience. A study of this work will also inform the buyer of machine tools what is considered best practice, both in the United States and in England, as to the design of machine shop tools. The text appearing in this volume is taken from a series of articles that are being published in *The Mechanical Engineer*, of Manchester, England, only the portion relating to turning machines, such as lathes, boring mills, etc., being included in this book. A companion volume is in progress which will treat of planing, slotting, drilling, milling and grinding machines, which will be of equal interest with this volume. The above work is an exceedingly valuable one and should be in the hands of everyone interested in machine shop operation. It is the only work of the kind that has been brought strictly up-to-date, covering the field as it exists to-day.

"Throw Away Your Glue Pot" is the advice appearing upon a neat celluloid paper cutter recently received from the Wachter Manufacturing Company, Baltimore, Md., which has been sent out in the interests of the well-known Army and Navy liquid glue, manufactured by this company. It is further stated that the above glue is not a "fish" glue, but a pure hide and sinew glue in liquid form. The Wachter Company will be pleased to send one of these souvenirs to anyone interested.

JEFFREY POWER DRILLS FOR ROCK AND COAL.—A catalogue of 40 pages has been received from the Jeffrey Manufacturing Company, Columbus, Ohio. which is a model of good printing, good engraving, fine paper and excellent arrangement. By aid of half-tone and line engravings the Badger rock drills, rotary drills, both electric and pneumatic, hand power drills, drill trucks, hose reels. portable pumps. electric hoists, electric locomotives and other product of this company is described. Each specialty is presented with terse statements of its advantages, so that the reader may at a glance ascertain the results of the many years of experience of these manufacturers.

LOCOMOTIVE SANDERS.—The American Locomotive Sander Company, Philadelphia, have issued a new catalogue of sanders which presents the principles of construction and use of these devices and illustrates various methods of application as well as showing the details of construction. It is admirably illustrated and is well printed. Copies may be had upon application to the company at Philadelphia.

THE CYLINDRICAL, ELECTRIC BLUE PRINTING MACHINE is described in a 30-page pamphlet issued by the Pittsburgh Blue Print Company, 1505 Park Building, Pittsburgh, Pa. A number of different styles of machines are illustrated, and the advantages of blue printing by electric light are set forth. The pamphlet also includes a large list of users of these machines and excellent testimonial letters from well-known firms.

ANATOMY OF CARS.—The Derry-Collard Company, 256 Broadway, New York. have issued a new edition of three railroad car charts with the parts named. These present the "anatomy" of a freight car, a passenger and a hopper gondola car. They were originally published by the *Railroad Car Journal* and are now printed on heavy plate paper, and are suitable for framing. They are mailed in a tube at 25 cents each, or 50 cents for the set of three.

"Dixon's Index for Pencil Users" is an interesting pamphlet devoted to the user of the lead pencil which has been issued by the Joseph Dixon Crucible Company, Jersey City, N. J. In their feeling of interest in the consumers of lead pencils they have issued this little treatise, from which one may easily select the pencil best adapted to their needs. The line of pencils manufactured by the Dixon Company is sufficiently large to supply the wants of all.

THE FORSYTH AUTOMATIC AIR AND STEAM COUPLER.—The construction and operation of this device are illustrated and described in a pamphlet just issued by the Forsyth Automatic Air and Steam Coupler Company, The Rookery, Chicago. Elsewhere in this issue is a descriptive article on this subject.

"Pumping by Compressed Air" is the title of an interesting pamphlet devoted to this subject which has recently been issued by the Pneumatic Engineering Company, No. 128 Broadway, New York. A number of the important installations that have been

made by this company are well illustrated and the simplicity, economy and flexibility of their systems of pumping by air are discussed. The subject is treated under three heads: the air lift pump; displacement pumps, using air expansively; and displacement pumps, using direct pressure of air without expansion. This pamphlet is instructive and is well worth careful reading.

CATALOGUE No. 36.—The Newton Machine Tool Works, Philadelphia, Pa., have recently issued a new 236-page issue of their general catalogue descriptive of the many lines of machine tools and supplies which are built by them. This company has made a specialty of building machine tools particularly adapted to the wants of railroad shop service and are meeting with the large trade which they deserve in this field. They also build tools for army, navy and general machine shop equipment, as well as also special tools of all classes of metal working machinery. A noticeable feature of this catalogue is the large number of tools illustrated therein which have been equipped for motor driving; the extent to which individual electrical machine driving has been developed cannot be better shown than by reference to this volume.

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WIRE ROPES AND CABLES.—The Broderick & Bascom Rope Company, St. Louis, Mo., have issued a new Price List E which is more than a price list. It is a convenient little catalogue of 52 pages devoted to their well-known product. The cover bears a half-tone from a photograph of the new factory. In addition to prices, the pamphlet contains illustrated descriptions of the brands of rope which have made the name of these makers so favorably known; tables of data, with reference to them, giving weight, capacity, diameter, etc., and similar information concerning hooks, sockets, thimbles, clips, shackles, ferry blocks and travelers, complete equipment for inclined planes, sheaves, blocks, and in fact everything needed in connection with wire rope service. Copies of this pamphlet may be had upon application to the office of the company, 809 North Main street, St. Louis, Mo.

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We are informed that the Double-Clutch Car Mover, manufactured by the Walter A. Zelnicker Supply Company, St. Louis, Mo., has been received by the trade beyond the expectations of either the manufacturers or the patentee. Among recent orders are one for 25 car movers from the Wabash Railroad; 25 from Cardenas, Cuba; 50 from Winnepeg, Canada; and many other smaller orders. This device, which only weighs 18 lbs., enables as many as three loaded cars to be moved by one man. For use in factories and warehouses having side track facilities, this device will pay for itself in a short time. The Zelnicker Company state that it is guaranteed in every respect, and further information will be cheerfully supplied concerning it.

The authorities of the Louisiana Purchase Exposition are taking every precaution to prevent the recurrence at St. Louis of any such disastrous fire as that which destroyed the great cold storage building at the Chicago Exposition in 1893, and are making adequate provision for water supply by putting in the largest installation of fire pumps in the world. These pumps, which have been purchased from Henry R. Worthington, of New York City, comprise 12 1,000-gallon, standard Underwriter fire-pumps, each capable of supply four fire streams, making it possible to have 48 fire streams in use at one time. The pumps are of the duplex, double-acting type and are supplied with air and vacuum chambers of large capacity. The fittings are of composition metal throughout, and the piston and valve rods are of bronze. Every measure has been taken in designing these pumps to insure that they will start at a moment's notice at any time after having been idle for a long period. They are the pumps recommended by the Associated Factory Mutual Insurance Companies, and, in fact, formed the basis of the specifications for fire pumps adopted by the Associated Companies.

The Standard Roller Bearing Company, of Philadelphia, have purchased the entire ball business of the Grant Tool Company, Franklin, Pa. (formerly of Cleveland, Ohio), and are prepared to fill all orders for the celebrated Grant ball, formerly made by the Grant Ball Company, of Cleveland, Ohio. In order to supply the demand at once for balls, the business will be run for a short time in Franklin, so that orders can be filled without delay, but it will eventually be moved to Philadelphia and consolidated with the Standard Roller Bearing Company's plant in that city. All orders should be sent to the Standard Roller Bearing Company, Philadelphia. R. H. Grant, formerly manager of the Grant Ball Company, will have charge of the ball-making plant in Philadelphia, and a number of the former employees of the Grant Company will remove from Franklin to Philadelphia and enter the employ of the Standard Roller Bearing Company.

In the past fortnight a number of notable orders have been received by the Crocker-Wheeler Company, of Ampere, N. J., and these, being fairly evenly distributed among its larger branch offices, indicate that the improving condition of business is not local to any one section. One order, from the Lorain Steel Company, Lorain, Ohio, called for 41 motors, ranging in size from 2½ to 360 h.p., and representing a total of 1,423 h.p. Another, from the New Jersey Zinc Company, of Hazard, Pa., for one 125 and two 600-k.w. generators, and 37 motors aggregating 401 h.p. The Philadelphia office placed an order from the Warren Foundry and Machine Company, of Phillipsburg, N. J., for one 200-k.w. generator, four 35-h.p. and two 60-h.p. motors; and the G. H. Hammond Company ordered for its packing plant at the Union Stock Yards in Chicago one 50, one 25 and two 20-h.p. motors and an 800-k.w., 550-volt, size 896 engine-type generator. This last is a duplicate of one now building for the St. Louis Exposition, the entire intramural plant for which will be operated by generators supplied by the Crocker-Wheeler Company.

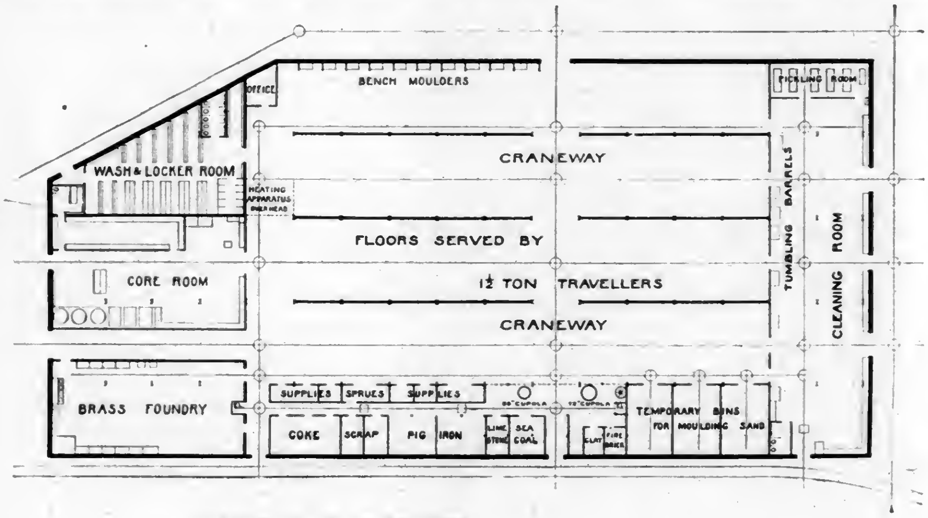
NEW FOUNDRY AND PATTERN SHOP.

THE B. F. STURTEVANT CO.

In our November number of last year a description of the new manufacturing plant of this company was shown. It is located at Hyde Park, Mass., and occupies 15 acres of ground. The foundry and pattern department were the first to be put into operation prior to the removal of the entire plant from Jamaica Plain.

The pattern building is divided midway of its length by fire-walls, enclosing stairs, elevators, etc. One-half of the building, with stories respectively 17 and 15 ft., is devoted to the flask and pattern-making rooms, while the other half, provided with intermediate floors, making four in all, is utilized for pattern storage. The flask-shop, measuring about 60 by 80 ft., is equipped with band, cross-cut and splitting saws, boring machine and lathe, all driven by a 10-h.p. Sturtevant motor suspended from the ceiling. The industrial railway runs directly into this room from the foundry, across a distance of about 40 ft., and, together with an overhead transfer track, reduces to a minimum the cost of handling flasks. The lumber for their manufacture is unloaded from cars directly in front of the building. This room also includes the metal patternmakers' department, equipped with the necessary machine tools. Adjacent thereto is the locker, wash and toilet-room for the building.

Immediately above is the pattern shop, abundantly lighted upon three sides, and equipped with a full complement of tools, including one single and two double saw benches, two band saws, a buzz planer and a double surfacer, five lathes, one of which is a 66-in. by 11½-ft. gap lathe; a drill press, a core-box machine, numerous wood trimmers, etc. All the power machines are operated by two 10-h.p. Sturtevant motors, both being required for ordinary work, but one always serving as a possible relay in case of accident.



GROUND PLAN OF FOUNDRY.

ONE OF THE TURNTABLES.

TRANSVERSE VIEW OF FOUNDRY.

The foundry consists essentially of two long craneways, each 35 ft. in width, with center bent of the same width, and side floors 30 ft. wide. The brass foundry, core-room and wash-room are located at one end; the charging floor at one side, nearly midway of the length, and the cleaning-room at the other end. The craneways are designed for 20-ton electric traveling cranes, equipped with Sturtevant motors.

Brick division walls 3½ ft. high, running lengthwise of the foundry, separate the floors on the lines of the columns. Lighting is secured through monitors in both of the craneways and through ample side windows. Each line of monitor transoms is operated in unison by a novel device installed by the G. Drouve Co. The western side of the foundry is given up to bench and small floor molding, the bench molders' floors being separated at the bench ends by wooden partitions. The floors throughout this side of the building, as well as those in the storage bins and center runways, are of concrete. Alongside the industrial railway, which serves iron from ladle trucks to the bench floors, is a sunken trench laid with common brick as a suitable place for drippings and for the piling of hot castings.

In the center line of each of the craneways and between them runs an industrial railway with turntables connecting with the cross aisles, which provides for the distribution of metal, etc., to all parts of the building. The floor between the craneways is supplied with a series of 1½-ton small traveling cranes of about 10 ft. span, equipped with Sturtevant electric hoists built especially for this work.

All materials are received from a track which runs along one side of the foundry, and are delivered through wall openings to the bins which fill a portion of the side wing adjacent to the cupolas. For the present the sand storage bins and mixing-room are also within this building.

The cupolas are two in number, of Whiting make, 56 ins. and 72 ins. in diameter. The opportunity has been improved to show the eminent adaptability of the Sturtevant pressure blower, a No. 8 and a No. 10 blower being driven, respectively, by a 30 and a 40-h.p. Sturtevant belted motor, being supported upon the charging platform through which they discharge directly downward and thence to the cupolas. It is intended to make this installation the subject of critical experiment for the establishment of important principles.

The entire transportation equipment of the plant, including tracks, cars, trucks, etc., was designed and built by the Sturtevant Co. The tracks in the foundry are embedded in the concrete runways, and all changes of direction are secured by turntables, there being no switches in the works, and therefore no radial truck cars, all cars having rigid bases. The turntables are designed very heavy to avoid distortion or breakage, and consist of a bottom frame, with four roller wheels, which are carried upon composition trunnions, and a cover, which is recessed for crossing tracks at right angles, and is provided on the under side with a chilled tread, with which the wheels come in contact. A small idler wheel is

made by this company are well illustrated and the simplicity, economy and flexibility of their systems of pumping by air are discussed. The subject is treated under three heads: the air lift pump; displacement pumps, using air expansively; and displacement pumps, using direct pressure of air without expansion. This pamphlet is instructive and is well worth careful reading.

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We are informed that the Double-Clutch Car Mover, manufactured by the Walter A. Zelnicker Supply Company, St. Louis, Mo., has been received by the trade beyond the expectations of either the manufacturers or the patentee. Among recent orders are one for 25 car movers from the Wabash Railroad; 25 from Cardenas, Cuba; 50 from Winnepeg, Canada; and many other smaller orders. This device, which only weighs 18 lbs., enables as many as three loaded cars to be moved by one man. For use in factories and warehouses having side track facilities, this device will pay for itself in a short time. The Zelnicker Company state that it is guaranteed in every respect, and further information will be cheerfully supplied concerning it.

The authorities of the Louisiana Purchase Exposition are taking every precaution to prevent the recurrence at St. Louis of any such disastrous fire as that which destroyed the great cold storage building at the Chicago Exposition in 1893, and are making adequate provision for water supply by putting in the largest installation of fire pumps in the world. These pumps, which have been purchased from Henry R. Worthington, of New York City, comprise 12 1,000-gallon, standard Underwriter fire-pumps, each capable of supply four fire streams, making it possible to have 48 fire streams in use at one time. The pumps are of the duplex, double-acting type and are supplied with air and vacuum chambers of large capacity. The fittings are of composition metal throughout, and the piston and valve rods are of bronze. Every measure has been taken in designing these pumps to insure that they will start at a moment's notice at any time after having been idle for a long period. They are the pumps recommended by the Associated Factory Mutual Insurance Companies, and, in fact, formed the basis of the specifications for fire pumps adopted by the Associated Companies.

The Standard Roller Bearing Company, of Philadelphia, have purchased the entire ball business of the Grant Tool Company, Franklin, Pa. (formerly of Cleveland, Ohio), and are prepared to fill all orders for the celebrated Grant ball, formerly made by the Grant Ball Company, of Cleveland, Ohio. In order to supply the demand at once for balls, the business will be run for a short time in Franklin, so that orders can be filled without delay, but it will eventually be moved to Philadelphia and consolidated with the Standard Roller Bearing Company's plant in that city. All orders should be sent to the Standard Roller Bearing Company, Philadelphia. R. H. Grant, formerly manager of the Grant Ball Company, will have charge of the ball-making plant in Philadelphia, and a number of the former employees of the Grant Company will remove from Franklin to Philadelphia and enter the employ of the Standard Roller Bearing Company.

In the past fortnight a number of notable orders have been received by the Crocker-Wheeler Company, of Ampere, N. J., and these, being fairly evenly distributed among its larger branch offices, indicate that the improving condition of business is not local to any one section. One order, from the Lorain Steel Company, Lorain, Ohio, called for 41 motors, ranging in size from 2½ to 360 h.p., and representing a total of 1,423 h.p. Another, from the New Jersey Zinc Company, of Hazard, Pa., for one 125 and two 600-k.w. generators, and 37 motors aggregating 401 h.p. The Philadelphia office placed an order from the Warren Foundry and Machine Company, of Phillipsburg, N. J., for one 200-k.w. generator, four 35-h.p. and two 60-h.p. motors; and the G. H. Hammond Company ordered for its packing plant at the Union Stock Yards in Chicago one 50, one 25 and two 20-h.p. motors and an 800-k.w., 550-volt, size 896 engine-type generator. This last is a duplicate of one now building for the St. Louis Exposition, the entire intramural plant for which will be operated by generators supplied by the Crocker-Wheeler Company.

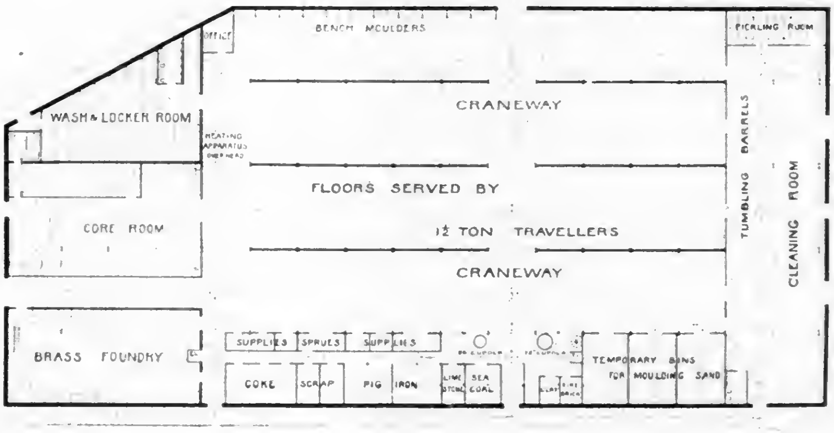
NEW FOUNDRY AND PATTERN SHOP.

THE B. F. STURTEVANT CO.

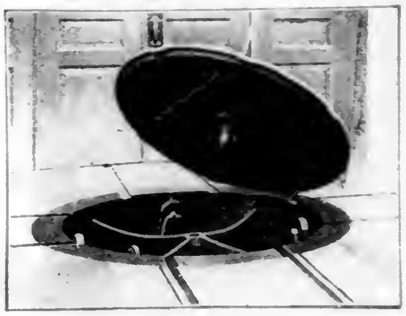
In our November number of last year a description of the new manufacturing plant of this company was shown. It is located at Hyde Park, Mass., and occupies 15 acres of ground. The foundry and pattern department were the first to be put into operation prior to the removal of the entire plant from Jamaica Plain.

The pattern building is divided midway of its length by firewalls, enclosing stairs, elevators, etc. One-half of the building, with stories respectively 17 and 15 ft., is devoted to the flask and pattern-making rooms, while the other half, provided with intermediate floors, making four in all, is utilized for pattern storage. The flask-shop, measuring about 60 by 80 ft., is equipped with band, cross-cut and splitting saws, boring machine and lathe, all driven by a 10-h.p. Sturtevant motor suspended from the ceiling. The industrial railway runs directly into this room from the foundry, across a distance of about 40 ft., and, together with an overhead transfer track, reduces to a minimum the cost of handling flasks. The lumber for their manufacture is unloaded from cars directly in front of the building. This room also includes the metal patternmakers' department, equipped with the necessary machine tools. Adjacent thereto is the locker, wash and toilet-room for the building.

Immediately above is the pattern shop, abundantly lighted upon three sides, and equipped with a full complement of tools, including one single and two double saw benches, two band saws, a buzz planer and a double surfacer, five lathes, one of which is a 66-in. by 11½-ft. gap lathe; a drill press, a core-box machine, numerous wood trimmers, etc. All the power machines are operated by two 10-h.p. Sturtevant motors, both being required for ordinary work, but one always serving as a possible relay in case of accident.



GROUND PLAN OF FOUNDRY.



ONE OF THE TURNTABLES.

TRANSVERSE VIEW OF FOUNDRY.

The foundry consists essentially of two long craneways, each 35 ft. in width, with center bent of the same width, and side floors 30 ft. wide. The brass foundry, core-room and wash-room are located at one end; the charging floor at one side, nearly midway of the length, and the cleaning-room at the other end. The craneways are designed for 20-ton electric traveling cranes, equipped with Sturtevant motors.

Brick division walls 3½ ft. high, running lengthwise of the foundry, separate the floors on the lines of the columns. Lighting is secured through monitors in both of the craneways and through ample side windows. Each line of monitor transoms is operated in unison by a novel device installed by the G. Drouve Co. The western side of the foundry is given up to bench and small floor molding, the bench molders' floors being separated at the bench ends by wooden partitions. The floors throughout this side of the building, as well as those in the storage bins and center runways, are of concrete. Alongside the industrial railway, which serves iron from ladle trucks to the bench floors, is a sunken trench laid with common brick as a suitable place for drippings and for the piling of hot castings.

In the center line of each of the craneways and between them runs an industrial railway with turntables connecting with the cross aisles, which provides for the distribution of metal, etc., to all parts of the building. The floor between the craneways is supplied with a series of 1½-ton small traveling cranes of about 10 ft. span, equipped with Sturtevant electric hoists built especially for this work.

All materials are received from a track which runs along one side of the foundry, and are delivered through wall openings to the bins which fill a portion of the side wing adjacent to the cupolas. For the present the sand storage bins and mixing-room are also within this building.

The cupolas are two in number, of Whiting make, 56 ins. and 72 ins. in diameter. The opportunity has been improved to show the eminent adaptability of the Sturtevant pressure blower, a No. 8 and a No. 10 blower being driven, respectively, by a 30 and a 40-h.p. Sturtevant belted motor, being supported upon the charging platform through which they discharge directly downward and thence to the cupolas. It is intended to make this installation the subject of critical experiment for the establishment of important principles.

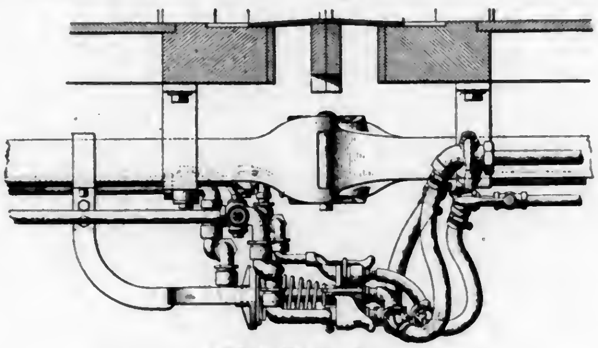
The entire transportation equipment of the plant, including tracks, cars, trucks, etc., was designed and built by the Sturtevant Co. The tracks in the foundry are embedded in the concrete runways, and all changes of direction are secured by turntables, there being no switches in the works, and therefore no radial truck cars, all cars having rigid bases. The turntables are designed very heavy to avoid distortion or breakage, and consist of a bottom frame, with four roller wheels, which are carried upon composition trunnions, and a cover, which is recessed for crossing tracks at right angles, and is provided on the under side with a chilled tread, with which the wheels come in contact. A small idler wheel is

provided, which automatically stops the turntable on each quarter, but readily releases it. The cover is accurately centered by a chilled conical bearing.

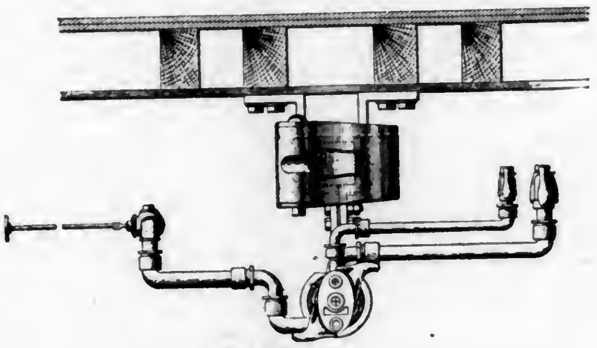
Naturally the entire plant is heated and ventilated by the Sturtevant system. In the case of the pattern building, the apparatus, consisting of an engine-driven fan and steel pipe heater, is placed close to the division wall, and delivers the heated air into a vertical flue and thence to the various rooms. The foundry apparatus is located overhead, in the end of one of the craneways, and arranged to take fresh air from out of doors or return from the building and reheat it. Distribution of air is made through a system of overhead galvanized iron piping, discharging downward to the floor. Both apparatus utilize exhaust steam. A complete underground tunnel system is provided for distribution of steam, electricity, compressed air, etc., and return of condensation.

THE FORSYTH AUTOMATIC AIR AND STEAM COUPLER.

This device is designed to avoid the difficulties which are everywhere experienced in maintaining air and steam hose connections between passenger cars. It combines metallic conduits, as substitutes for hose, with automatic couplers, which render it unnecessary to couple the connections by hand. The construction of the device is illustrated in the accompanying engravings. In the coupler heads three openings are provided, for the air signal, the air brake and the steam lines, in the order named. The heads are supported by conical springs attached to curved brackets which are attached to the stems of the drawbars. Connections to the train pipes are made by flexible metallic conduits with metallic joints, and these take the place of rubber hose connections. To drain the steam connections and prevent freezing, automatic drips are provided near the coupling heads and these open when the steam pressure is removed, allowing the connections to free themselves of water.



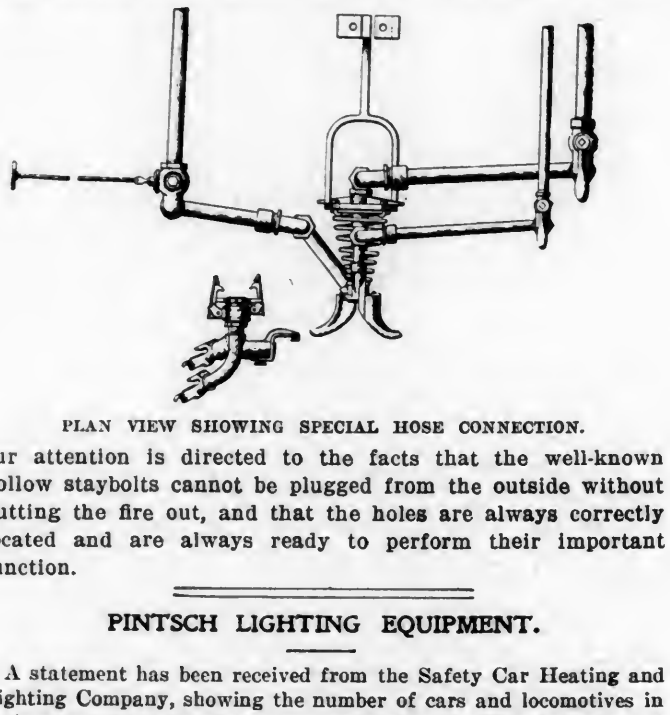
SIDE ELEVATION.



END ELEVATION.

THE FORSYTH AUTOMATIC AIR AND STEAM COUPLER.

In the act of coupling, these heads are pressed together by the spiral springs and sufficient pressure is maintained to prevent leakage of the joints. The pipe couplers move with the car couplers and couple simultaneously with them. For connecting these devices to cars which are equipped with hose an emergency head is provided. One of them is shown in connection with the plan view. These couplers have been in use for over two years on suburban cars of the Chicago, Milwaukee & St. Paul Railway, passing four times every day over 20-deg. curves in Chicago, and they are reported to have given no trouble by leakage. The device is also in use on the Chicago & Alton and the Frisco system. Further information may be had from the Forsyth Automatic Air & Steam Coupler Company, The Rookery, Chicago.



PLAN VIEW SHOWING SPECIAL HOSE CONNECTION.

DANGEROUS PRACTICE OF PLUGGING STAYBOLTS.

Attention has recently been directed to the fact that on some railroads men in the roundhouse are permitted to plug the tell-tale holes in broken staybolts with wire nails and the ends of files, which are tightly driven in to stop the leaks. It seems incomprehensible that anyone who knows what these holes are for can be guilty of such work, or that any but an unworthy master mechanic can countenance it for a moment. We are, however, assured that it is done. The drilling of these holes is vitally important to the safety of a locomotive boiler and it behooves those in responsible charge to see that the work is carefully and properly done. When, by the escape of steam, the holes indicate breakage of bolts, the boilermakers cannot get new bolts in too quickly. Men must necessarily be available night and day for such work. A broken bolt which gives this signal of its fracture may be surrounded by fifty others which are broken nearly to the hole and yet do not indicate their weakness. Because of the difficulty of discovery of partial fractures the best precautions must be taken to guard against this danger. In connection with this subject our attention is directed to the facts that the well-known hollow staybolts cannot be plugged from the outside without putting the fire out, and that the holes are always correctly located and are always ready to perform their important function.

PINTSCH LIGHTING EQUIPMENT.

A statement has been received from the Safety Car Heating and Lighting Company, showing the number of cars and locomotives in various countries which are equipped with the Pintsch system of compressed gas lighting. It also includes the number of Pintsch gas works now in operation and shows the number of gas buoys and beacons which are in service. The statement, which is complete to May of this year, is tabulated as follows:

	Cars.	Locomotives.	Gas Works.	Buoys and Beacons.
Germany	42,850	5,200	71	145
Denmark	45	..	3	21
England	19,200	18	87	272
France	6,758	..	27	240
Holland	3,487	5	10	166
Italy	1,537	..	5	15
Switzerland	392	2	1	..
Austria	4,758	..	10	1
Russia	3,360	132	13	21
Sweden	710	43	4	2
Servia	216	..	..	..
Bulgaria	98	..	1	..
Turkey	114	..	..	..
Egypt	76	..	3	118
Canada	202	..	3	97
Brazil	974	31	1	83
Argentine	1,130	..	10	2
Chili	46	..	2	..
India	10,200	..	16	..
Australia	2,053	..	13	88
United States	20,550	..	68	190
Japan	150	..	2	4
China	....	..	1	15
Mexico	121	..	1	..
Total	119,031	5,431	347	1,380
Increase for the year	6,840	434	..	169

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

DECEMBER, 1903.

RAILWAY SHOPS.

BY R. H. SOULE.

VIII.

THE PLANING MILL.

(Including the Cabinet Shop and Lumber Yard.)

The planing mill, cabinet shop, and lumber yard are so mutually interdependent that they must necessarily be considered together, and in nearly all plants they are under the same joint supervision. As they contribute their product to the construction and repair of both locomotives, passenger equipment cars, and freight equipment cars, and usually to the maintenance of building as well, both inside and outside of the motive power department, it is evident that their proportions can not be expressed on the unit basis; that is to say they cannot be definitely and completely stated, in so many square feet of floor space per locomotive stall or per car stall.

The only practicable method of approximating the dimensions, proportions, and relative arrangement to be adopted for these departments of a proposed plant, is to list up the principal existing general railway repair plants of the country, stating opposite each its estimated standing capacity for locomotives, passenger equipment cars, and freight equipment cars, together with the floor areas for planing mill, cabinet shop, and total. The analysis of such a tabulated statement will afford the only known basis for adopting proportions, but even then it must be determined what relation construction work and repair work are to bear to one another. Such a list will disclose the fact that planing mill proportions vary between very wide limits, and do not even approximate to fixed or standard ratios; also that the proportion of space allotted to planing mill and cabinet shops are hard to determine; this being largely due to the fact that cabinet shop work is partly machine labor and partly hand labor, and in many plants the machine work is done in the planing mill, and only the hand work done in a distinctive place of its own. Such a list will also disclose the fact that the combined planing mill and cabinet shop department of the new general shops of the Canadian Pacific, at Montreal, lead in point of size and capacity, their floor space, in square feet, being, planing mill 63,500, cabinet shop 17,980, total 81,480; there are two or three plants where the cabinet shop is slightly larger, but none which approach this in general floor area. The reasons for providing this exceptionally large planing mill plant are principally the facts that lumber and labor are both cheap in Canada, and the conditions are generally favorable for building both passenger equipment cars and freight equipment cars; besides which there are very few outside establishments in Canada which are able to handle such work on a large scale, and the great car building shops of the United States are too remote to be economically availed of. A close second to the Montreal plant is that of the New York, New Haven and Hartford, at Readville, Mass; here the floor areas, in square feet, are, planing mill, 43,750; cabinet shop, 20,000; total, 63,750. Readville is the nearest example of a large and modern railway planing mill plant.

When the layout plan of a proposed new shop has been completed, the first impression to anyone who has not individually worked on the problem is that the planing mill is very large relatively to the other buildings; but when that shop is considered in detail, the use of liberal proportions are easily justified. Both the bulk and the quantity of materials handled through a planing mill are very large as compared with those handled in any one of the iron working departments, the machine shop, for instance; and in the planing mill these conditions multiply upon themselves for the reason that in general, floor storage space must be provided both before and after each handling through a machine. It is for this reason that the ratio of floor area to the number of machine tools is much greater in planing mills than in machine shops, a well known fact. The easy and economical movement of lumber through the planing mill restricts such movement to the direction of the length of the pieces being handled, and this forbids the use of anything, but a building which is relatively long and narrow, which is the accepted type of planing mill building, subject to considerable variation in the exact proportion of length to width. Where buildings of a different type and shape are found, it is generally the case that the plant is small or of moderate size, and that the planing mill has been combined with a car shop for either passenger work, freight work, or both.

In a combination repair shop, locomotive cabs are usually repaired in the cabinet shop, and make a considerable demand on floor space; this fact is only one of several which constitute a strong argument for keeping the cabinet shop on the ground level, but nevertheless there are several cases where they are on a second floor, even where the layout suggests that they could easily have been located on the general ground level. It will, however, be found very burdensome and expensive to conduct a cabinet shop on the second floor; the bulk and weight of material to be handled both in and out of the shop is very considerable, and the finished product goes principally into passenger equipment cars, requiring that men from the cabinet shop must follow it and fit it in place; and in a large plant this must necessarily be done on the ground floor of another building separate and distinct from the planing mill. The preferred location for the cabinet shop is therefore on the ground floor and intermediate between the planing mill and passenger car shop, and actually under the same roof with one or the other; such is the arrangement at Readville, and it is ideal in that respect.

The amount of power required to drive a planing mill is also a surprise when the problem is first approached; although the cutting resistances of lumber are small relatively to those of iron, yet very high cutting speeds are practicable, and their products, the power used, is high. With the steam engine as prime mover its rotative speed, especially for high powers, being limited to low figures, the typical planing mill of previous days has been an object lesson which probably will find no parallel in the future; the necessarily great increase in rotative speed from the prime mover engine to the various tools, required the use of trains of pulleys alternately of maximum and minimum practicable sizes; the design of the various tools required that some should be driven from transverse shafts and some from longitudinal shafts; this brought into the combination the quarter twist belt with its mule pulleys, etc.; the strains on the belting and shafting being intermittent and in directions at right angles to one another, the roof had to be heavily trussed and braced to absorb the vibrations. The planing mill designed and built to-day may be free from all these troubles; the engine and boiler room annex is dispensed with and absorbed in the main power plant; there is no jack shaft, that is no single overhead shaft through which the entire power of the planing mill is transmitted, and which, in old time practice was the source and centre of the annoying vibrations before referred to. In the planing mill of to-day each tool or each group of tools may have its own motor, usually firmly placed on the floor; no quarter twist belt is required, and the application of power is so subdivided throughout the building that vibrations of the structure are not apparent. At Readville there are nine transverse shafts driven by five motors, all placed on the floor, and supplying the bulk of the power for the mill; the few remaining tools, which,

either from their design or from convenience of handling materials, are placed at right angles to the general run of tools, are driven by individual motors supported from the roof trusses. Large pulleys are noticeably absent, as the high motor speeds make their use unnecessary.

The course which materials follow in being passed through a planing mill is much more definite and uniform than in the case of the machine shop, for instance; it is consequently obvious that wood working tools should be located in a certain general sequence, such as cut off saws, rip saws, timber planers, planing and matching machines, tenoning machines, mortising machines, etc., with the other lighter and miscellaneous machines filling in the odd spaces.

As practically all wood-working tools are run at constant speeds, and as the planing mill is the one particular place where sparks are a dreaded source of danger, it becomes the ideal place for the use of the alternating current induction motor, which is both constant speed and sparkless. These considerations would seem to compel the exclusive use of the alternating current in planing mill work, and indicate that what may be called a combination power plant, that is a plant producing and distributing both direct current and alternating current, is ideal for a general railway repair plant. The rapid development and perfection of alternating current apparatus, and the increasing confidence in its use, make the combination practicable, and several such combination power plants are to be found in railway practice.

The disposition of shavings is somewhat more difficult than formerly; in the old steam driven plant the adjacent battery of boilers simplified the problem, and the movement of shavings whether by hand or by blast was a comparatively simple matter; under the present conditions of electric drive, the central power plant is often so far removed from the planing mill, that the problem of disposing of the shavings presents considerable engineering difficulties; this has led, in some instances, to placing a boiler locally at the planing mill, firing it with shavings and using the steam in the dry kiln throughout the year, and also for heating in the winter season.

Two necessary adjuncts to the planing mill are the dry lumber shed and the dressed lumber shed; these are often overlooked and neglected in the original layout, but being of essential importance, and vital parts of the plants, should properly be included and considered as part of the original problem; they are too often omitted from the original design and construction, and if subsequently provided at all, are apt to be of insufficient capacity under stress of restricted appropriations. Under the head of dry lumber is included all hardwood and expensive lumber whether kiln dried or not, and obviously its proper place is at the incoming end of the mill; the dressed lumber shed is particularly useful where many freight equipment cars are to be built new, as the conditions of economical production require that the planing will should keep ahead of the erecting shop, and therefore the dressed lumber shed should be between the two. Fine structures for dry lumber are found at both Montreal and Readville, but no separate shed for dressed lumber appears on the plans for either place; if the dry lumber sheds are used for the storage of dressed lumber as well, it must necessarily be accomplished by at least one retrograde movement.

The dry kiln is still more important, but is little understood, as exact information regarding its arrangement, proportions, and output, is very scarce, and such information as is on hand is widely scattered and seldom available. The Division of Forestry of the United States Department of Agriculture, at Washington, D. C., is collecting information on the subject and intends to issue a bulletin embodying facts and conclusions: this is very much needed and will be of very great service. It is known, however, that the forced circulation produced by the fan in the modern dry kiln has very greatly increased its output, as compared with the old method of natural draft. The dry kiln at Readville is the latest and most accessible example of good practice in this line. The New Haven road has nearly 2,000 passenger equipment cars, including, in this case, both sleeping cars and parlor cars, which is not usual; Readville being intended as the principal maintenance point for these cars, a capacious and efficient dry kiln plant was a necessity. Special all-steel long-wheel base standard gauge trucks are surmounted each by two smaller transverse trucks forming a cradle on which lumber is stacked; when the combination is run into one of the compartments of the dry kiln, the two cradle trucks with their load are run off on lateral tracks which are arranged at a proper level, and allowed to remain there until the drying process is completed; the main standard gauge truck, thus released, is available for handling other loads in or out. A system of external turntables completes the arrangement by which the several compartments of the dry kiln are brought into proper working relation with the lumber yard and planing mill tracks. In some modern dry kilns the moisture charged air which has been forced through and over the wet green lumber is subsequently passed between chilled pipes, by which means the moisture is precipitated and the air may thus be used over and over again, and kept warm with a moderate use of fuel, which is a measure of economy, especially in cold countries.

A study of lumber yard layouts leads to the conclusion that only a few have been carefully planned, while the majority are haphazard in their general features, and some are thoroughly inconvenient. It is believed that the most convenient plan is for the road tracks to be connected to a ladder at one end only, these main or road tracks to be spaced about 30 ft. centres, and to have a cross connecting track, with turntables, at the end of the yard opposite to the entrance ladder; the 30 ft. spacing makes it possible to stack 16-ft. boards crosswise to the tracks, and leave proper clearances at both ends, while long heavy stuff, such as sills, may be piled parallel to the tracks, practice having proven that these methods of handling these two classes of lumber are most convenient and economical; short oak and miscellaneous stuff may be stacked either way, in order to utilize remaining space to the best advantage. With a lumber yard so arranged every pile of stuff may be reached by a hand truck from either one of two adjacent tracks, the chances of both tracks being blocked being very remote. A very good alternative arrangement is to have only every other track connect with the ladder, the intermediate tracks being of lighter rail, and for the use of hand trucks only, road cars having no access to them. With this arrangement the cross tracks may be provided with turntables at every intersection with a longitudinal track or only at its crossings with the intermediate light rail tracks, either arrangement being practicable. One or two of the lumber yard tracks are run through the planing mill, and besides being used currently for trucking lumber in and out of the mill, will often be found convenient for handling car load lots of finished lumber for shipment to outlying points. At the West Burlington shop of the C. B. & Q. a depressed track enters the mill building at one end for use in this connection.

It will be found a very convenient working arrangement to locate the joint office of the planing mill foreman and the lumber yard foreman (and the lumber inspector, if there is one,) in the open space between the planing mill and the lumber yard, and in general, the dry kiln is within reach and observation from this point.

Up to the present time hand labor has been exclusively employed in lumber yard work, but with operations conducted on such a large scale as contemplated at Montreal and Readville, it seems entirely probable that labor saving appliances and machinery electrically driven, could be introduced to advantage. These two large plants are simply precedents in point of size, and may be frequently duplicated, or even exceeded in the future, and the mechanical talent on our railroads should not fail to grasp and meet the situation in this respect.

(To be continued.)

The Western Railway of France, has adopted electric heating for their special "corridor" trains, after an extended series of tests. Each car is to be equipped with ten electric heaters, of the foot-warmer type, which will be arranged in two circuits of five each.

STEEL CAR DEVELOPMENT.

PENNSYLVANIA RAILROAD.

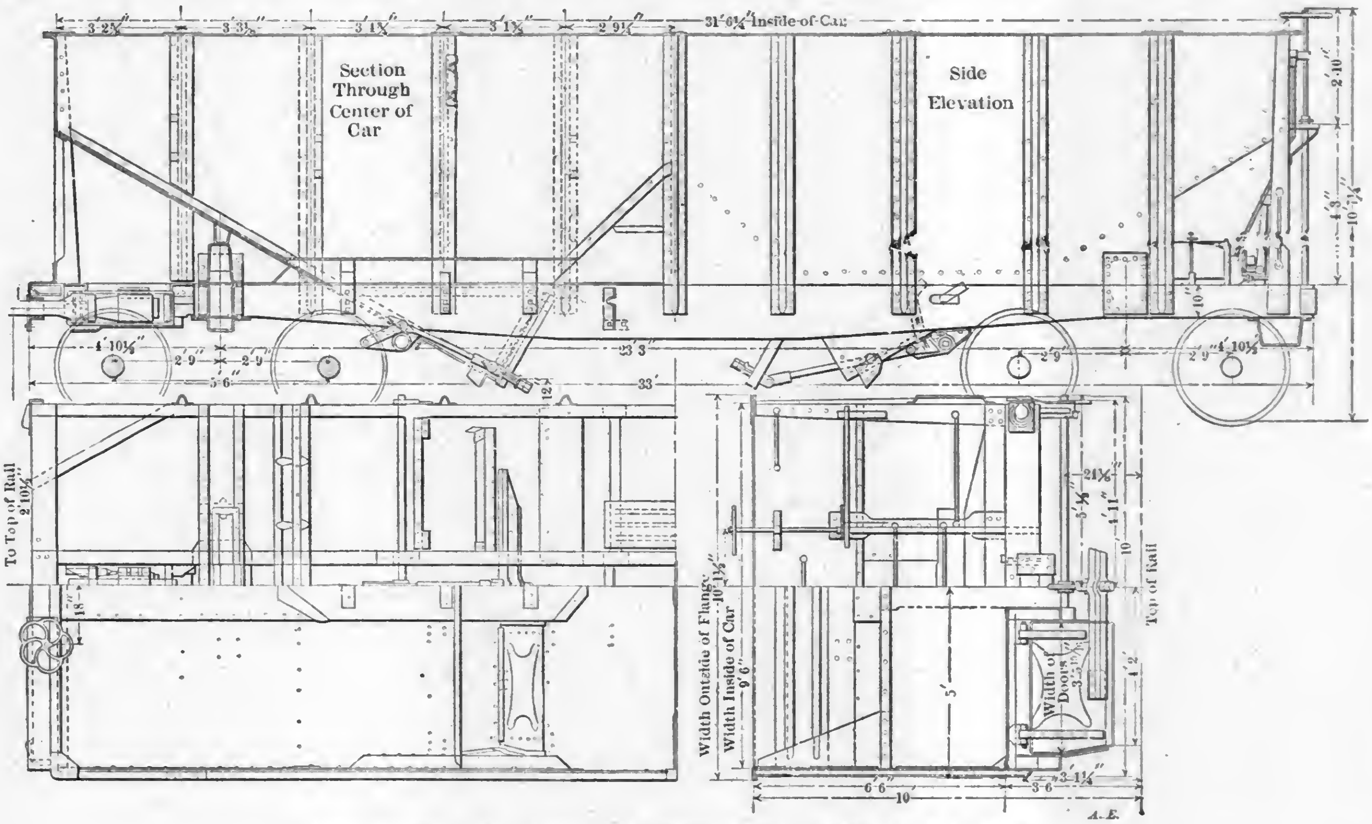
III.

(For previous article, see page 402.)

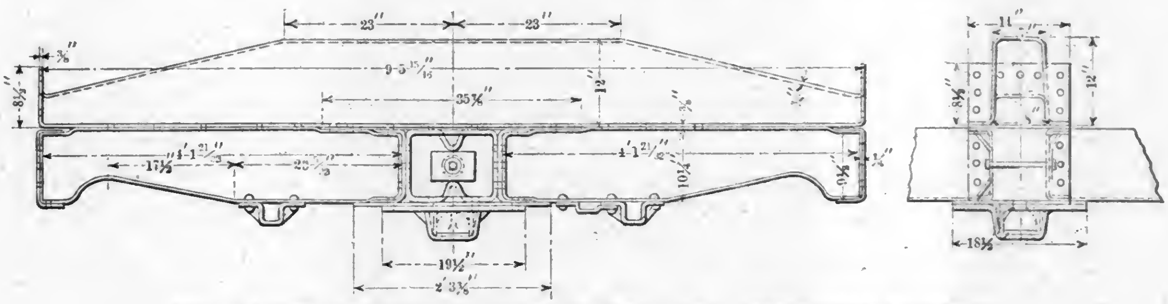
The first large all-steel, twin copper gondolas for the Pennsylvania Railroad were delivered by the Pressed Steel Car Company July 27, 1898. It seems but a short time since this important step in steel car development was taken. It was an important step because this GL car remains until now the standard coal car of this road. This type of construction was brought out in pressed steel on the Bessemer & Lake Erie, and its adoption by the Pennsylvania settled the form and type of the largest number of steel cars built in this country up to the present time. As already pointed out, the form was drawn from the class GC wooden car. The design of the GL car was contemporaneous with the GM car, illustrated in this journal in November. It is almost exactly the same now as when first designed, but it will probably be redesigned in order to save weight, but without in any way impairing its strength. This car was built originally for the lines west of Pittsburgh and was used for coal in one direction and ore in the other. It was designed by the Schoen people, and adopted by them, with modifications, for a large part of the equipment of this type built for other roads.

As shown on page 354, the weight of the GL car is 39,150 lbs. Its cubical capacity is 1,897 cubic ft., including the heap over the top, and the ratio of dead to paying load is 36.4 per cent. Its success is due to the fact that the facility of unloading coal and ore made it very popular with shippers.

The backbone of the GL car is a pair of fish-bellied pressed steel channels 17 in. deep at the center and 10 in. deep at the ends. They are continuous through the length of the car, 33 ft., and the bolsters are riveted to them. These sills receive the draft gear and are spread 12⅞ in. apart to receive the Westinghouse friction gear, which has been applied to all of the recent steel cars on this road. The side sills of this car are also continuous and of the same form and size as the center sills, except that the side sills are of ¼ in. plate, while the center sills are ⅜ in. thick. In both cases the flanges of the channels are 3⅞ in. wide. This construction neglects the possibility of utilizing the sides of the car as trusses to aid in carrying the load and the heavy side sills might have been omitted, which would have saved a great deal of weight and considerable expense.

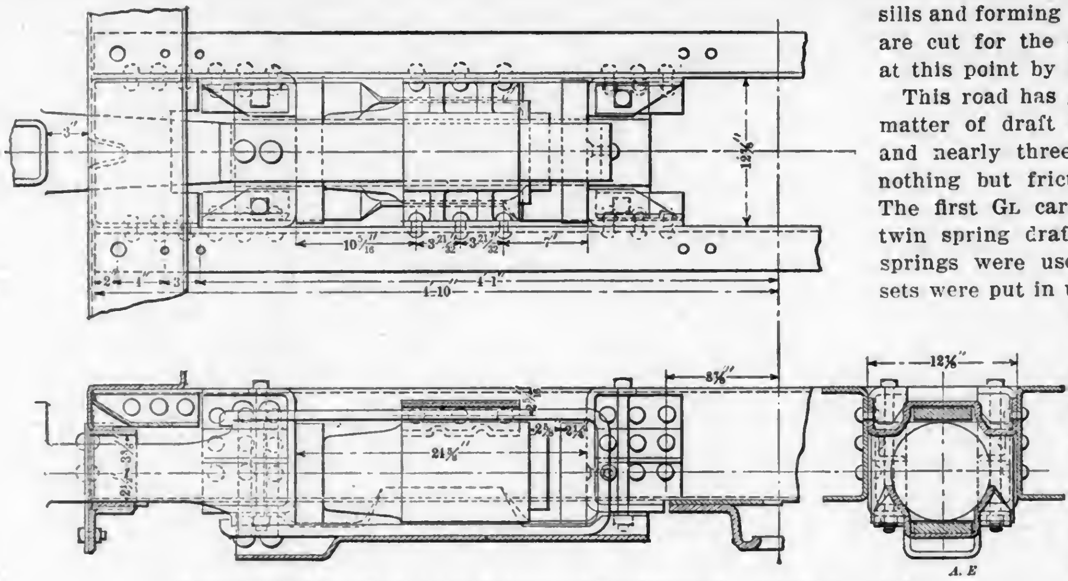


CLASS GL STEEL CAR. STEEL CAR DEVELOPMENT—PENNSYLVANIA RAILROAD.



BODY BOLSTER CONSTRUCTION—CLASS GL STEEL CARS. PENNSYLVANIA RAILROAD.

With continuous center sills the lower portions of the body bolster were cut and made in the form of trough-shaped diaphragms, but the bolster proper lies on top of both center and side sills, and by its form is made to take some of the load from the sloping floor through a trough-shaped floor support, which bears on the bolster. This arrangement gives plenty of room for the bolsters, and it is easy to understand why these cars do not get "down on their side bearings." The



DETAILS OF DRAFT GEAR ATTACHMENT—WESTINGHOUSE—CLASS GL. CARS.

accompanying drawings are selected with a view of rendering an extended description unnecessary.

In all of the later forms of construction the center sills are continuous, and the bolsters are formed of trough-shaped diaphragms between them, with longer trough-shaped diaphragms between the center and side sills, riveted to their webs.

The end sills of the GL car are trough-shaped pressed plates Westinghouse friction gear had been long enough in service to determine whether it had reached its full development, and as a matter of fact, a number of changes were after- of ¼-in. material, fitting over the end of the longitudinal sills and forming strong end construction. They are cut for the coupler shank and reinforced at this point by pressed plate angles.

This road has gone very thoroughly into the matter of draft gear for large capacity cars, and nearly three years ago decided to apply nothing but friction gear to this equipment. The first GL cars were equipped with double twin spring draft gear in which two sets of springs were used in pulling and two other sets were put in under initial compression with but ⅝-in. of motion left. In buffing the follower pushed in pins which acted through the center of the springs, against the follower plate and loaded the second pair of springs. At the time this gear was designed it was not thought that the Westinghouse friction gear had been long enough in service to determine whether it had reached its full development, and as a matter of fact, a number of changes were afterward made in it. The spring gear gave fair service, but it was soon found that the Westinghouse gear was perfected so as to offer substantial advantages over springs alone, and the spring gear was abandoned in its favor. Since its first adoption this road has not used any but friction gear on large capacity cars. The Sessions standard friction gear is now applied to a number of cars on this road. The form of attachments for the Westinghouse draft gear on GL cars is illustrated in one of the accompanying engravings. In fact this arrangement is the one in use on all present types of steel cars on this road.

THE APPRENTICE QUESTION.

Mr. W. O. Thompson, division-superintendent of motive power of the New York Central at Oswego, N. Y., in a paper read last month before the Central Railroad Club, presented some of the features of the apprentice problem, in a way which should revolutionize practice in every railroad shop in the country.

In the opinion of the editors of this journal Mr. Thompson stated the case better than it has ever been stated before. The following paragraphs indicate its practical and sensible character. The author is certainly correct as to wages, unless the railroads establish schools for apprentice instruction:

"The average American boy, enters railroad shops at a salary that is not sufficient to take his girl to the circus and buy peanuts, all in the same evening, it does not take him long to see that the helper who does not know as much as the boy, after he has served three months, is getting enough to make him a comfortable living, and that if the helper shows himself a little proficient in some certain part of the business, he is paid a full-fledged mechanic's wages in a year or two. He also notices that it has been the policy of the railroads to better the condition of every one in financial and other ways from the president to and including the 'Dagos' on the section, with the exception of the apprentice. He also notices that he is looked upon with disfavor by a good many mechanics and barely tolerated by the sub-foremen; seldom noticed by the general foreman; and in a good many cases the division officer or superintendent of motive power is further away from him than the North Star. Under such circumstances is it any wonder that our boys get discouraged?

"What is needed is a complete change of heart and methods in regard to the apprentices. Instead of considering them as apprentices, we should look at it in the same light as we do in turning out more work every year for a given amount of money and the pace should be set by the highest division officer, and he should consider the welfare of his apprentices his paramount duty, and in that way create the opportunity of filling his shop with men fully prepared to successfully cope with their chosen profession.

"Apprentices' wages are altogether too low. Instead of compelling the boy to work one year for 5 or 6 cents an hour, he should work only six months for that pay. The next year his wages should not be less than $1 a day. The next year he should be paid nearly as much as the ordinary helper. The next year and the last six months of the fourth year he should be paid as much as the ordinary and special helpers' respectively. It is of the utmost importance that very careful consideration be given to the critical period of a boy's life, that is at the time of the completion of his apprenticeship. The practice of discharging an apprentice when his time is out is decidedly wrong. The proper time to get rid of undesirable apprentices is the first six months or a year at the latest.

"Satisfactory results cannot be obtained in any apprentice system without the proper interest being taken by the foremen to train an apprentice. The apprentice is the coming foreman, master mechanic and superintendent of motive power. The most vital part in the training of apprentices is the selection of mechanics as their instructors. It is not possible to obtain even medium results with boys without developing them outside of shops and to gain that which will be of lasting benefit to the boys and railroad companies as well, and an apprentice club or association should be formed where boys who have not been fortunate enough to get technical education can secure information on a variety of subjects that will put them on an equality which their more fortunate brothers. No apprentice system that can be devised will ever be a success unless every one, from the highest official to the mechanic entrusted with the education of the boy, appreciates the responsibility connected with starting an apprentice.

"We all point with pride to our special apprentice boys who have had the advantage of a technical training. We spend our company's money to re-educate them to the practical side of railroad life and as far as my observation goes with the same amount of money spent and the same pains taken in the way of giving the ordinary apprentice a chance for self-education suitable for shop apprentices, we will get better mechanics, more capable foremen and officers for higher positions than can be obtained in any other way."

NEW PASSENGER LOCOMOTIVE.

WABASH RAILROAD.

4—4—0 TYPE.

At the Brooks works of the American Locomotive Company some fine new passenger locomotives are being completed for the Wabash Railroad. They have steel frames, cast in a single piece, piston valves with inside admission and direct motion. The tractive effort is 23,500 lbs. In the drawings of the boiler the tendency toward providing wider water spaces for circulation is noticeable. The water space in front of the firebox is 5 in., at the sides and back the space is 4½ in. The tubes are 2 in. in diameter, with ¾ in. bridges. These engines have brake shoes on all wheels, including the trailers and truck wheels. For the trailers the usual provision for side motion is made. These locomotives are equipped with high-speed Westinghouse air brake, with retaining valves on the drivers.

PASSENGER LOCOMOTIVE—WABASH RAILROAD.

Ratios.

Heating surface to cylinder volume	= 257
Tractive weight to heating surface	= 36.2
Tractive weight to tractive effort	= 4.75
Tractive effort × diameter of drivers to heating surface	= 703
Heating surface to tractive effort	= 11.4%
Total weight to heating surface	= 68.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	180,700 lbs.
Weight on drivers	96,700 lbs.
Weight engine and tender in working order	310,700 lbs.
Wheel base, driving	7 ft. 6 ins.
Wheel base, rigid	7 ft. 6 ins.
Wheel base, total	30 ft. 11½ ins.
Wheel base, total, engine and tender	56 ft.

Cylinders.

Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	6½ ins.
Diameter of piston rod	3¾ ins.
Size of steam ports	1¾ ins. x 25½ ins.
Size of exhaust ports	65 sq. ins.

Valves.

Kind of valves	Piston
Greatest travel of valves	5 9-16 ins.
Outside lap of valves	1¼ ins.
Inside lap of valves	0 ins.
Lead of valves in full gear	1-16 in.

Wheels Etc.

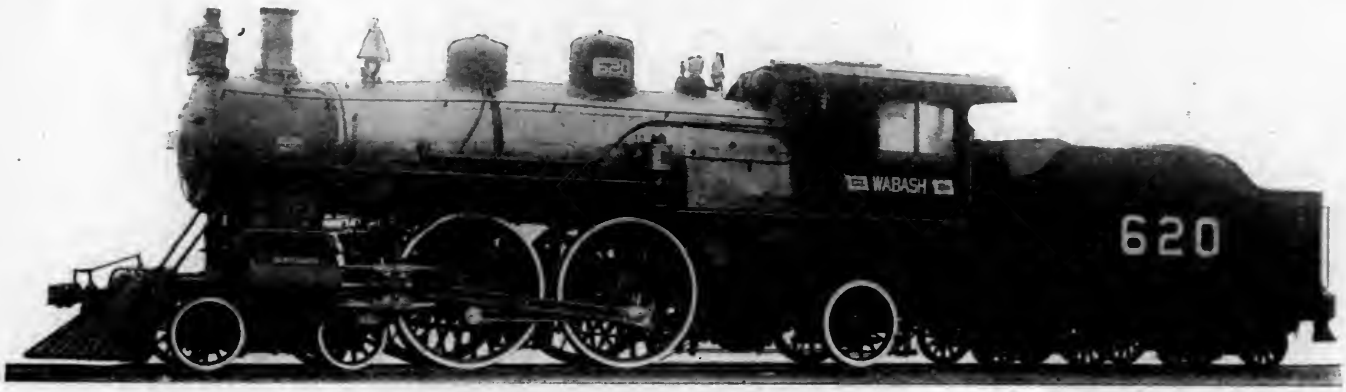
Number of driving wheels	4
Diameter of driving wheels outside of tire	83 ins.
Material of driving wheel centers	Cast steel
Thickness of tire	3½ ins.
Tire held by	Shrinkage and retaining rings
Driving box material	Cast steel
Diameter and length of driving journals	9½ ins. diameter x 12 ins.
Diameter and length of main crankpin journals:	6½ ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals:	7¼ ins. diameter x 4¼ ins.
Engine truck, kind	Swing
Engine truck journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	36 ins.
Kind of engine truck wheels	McKee-Fuller spoke

Boiler.

Style	Radial stayed extended wagon top
Outside diameter of first ring	64¼ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox:	11-16, ¾, 9-16, ½, ½ in.
Firebox, length	102 ins.
Firebox, width	63 ins.
Firebox, depth	Front, 75½ ins.; back, 65½ ins.
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 5 ins.; sides, 4½ in.; back, 4½ ins.
Tubes, material and gauge	Iron; 11 B. W. G.
Tubes, number	294
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft. 4 ins.
Heating surface, tubes	2,499 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	2 676 sq. ft.
Grate surface	43.7 sq. ft.
Grate, style	Rocking
Exhaust nozzles	5⅛ ins. diameter
Smoke stack, inside diameter	14½ and 16¾ ins.
Smoke stack, top above rail	15 ft. 3 ins.
Boiler suplied by	Two No. 10 Ohio injectors

Tender.

Style	Eight-wheeled
Weight, empty	55,460 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	17 ft.
Water capacity	6,000 U. S. gals.
Coal capacity	12 tons



PASSENGER LOCOMOTIVE—4-4-2 TYPE—WABASH RAILROAD.

J. B. BARNES, *Superintendent Motive Power*.

AMERICAN LOCOMOTIVE CO., BROOKS WORKS, *Builders*.

WHY DO STAYBOLTS BREAK?

The following is taken from a paper read at the Foreman Boiler Makers' Convention at Chicago by Mr. John Livingstone:

Your chairman produced a board to show 171 heads of staybolts from the right side of the fire box on the fireside sheet of a locomotive; at least 75 out of the 171 were burned. You have held that the breakage of staybolts is due to expansion and contraction, and unable to counteract the expansion and contraction with the solid staybolt, discussion centered on flexible staybolts.

Too little heed was paid to the lesson taught on the board, too little consideration was given to the prima facie fact, that 44 per cent. of the heads of those staybolts were burned. When the bolts commence to burn at the inside of the sheet, the burning continues inward until protected by the water. The heat that causes the burning causes expansion at its inner end, and in the hole of the sheet; and that expansion is met by resisting expansion in the sheet (solid against solid) with risk that both the sheet and the bolt will crystallize. The sheet, which may also burn, may crack between the bolts; the bolts will break, not always where the force of rigid compression obtains; sometimes where by the concentration of force there, the other part of the bolt snaps under the varying vibrations and strains it has to endure. The sheet in ordinary service cannot be burned so long as there is water behind it, for iron has capacity to convey to the water the heat it obtains from the fire, however fierce; but if burning is commenced at the inner end of the staybolt it will extend outward and imperil the sheet immediately around it.

Though riveted close to the plate the inner end of the bolt is only mechanically in touch with the plate, and cannot exercise the functions of the sheet in giving to the water the heat by which it is attacked. The water protects the sheet from burning and the heat passes through the iron to the water.

To avert the risk of burning from the inner end of the bolt outward, there is only one way and that is with air through the center of the bolt and the water around it; nor can you unduly expand a bolt of that character. It will receive the force of the expanding sheet without the resistance of its own power of expansion to the extent occurring in a solid bolt.

RAILROAD SHOP MANAGEMENT.

By William S. Cozad, Norfolk & Western Railway.

I.

Long experience in locomotive and car shop work has proven very conclusively, I think, to the average shop manager that any system of shop supervision that is not founded on the principle of co-operation or of renumerating the employee according to the amount of service performed, whether of brain or muscle, affords neither substantial justice to the workman, for sufficient returns to the owner for capital invested.

In a railway repair shop where almost every conceivable class of work is performed from tapping a nut to building a locomotive complete, it is generally conceded, in the light of all the knowledge we have on the subject at present at least, that straight piece-work or a fixed price for each operation, when properly applied, is best adapted to such a great variety of work. The object of this article, therefore, will be to discuss in a general way, the subject of shop organization and the relation which must exist between the management and the men before any decided steps can be taken towards putting the shop on a satisfactory piece-work basis.

In entering into this work it is necessary to understand that the introduction of piece-work in any department changes, not only every condition, but the entire atmosphere of the shop, and one of the first things to be remembered by the foreman is that he is dealing with a body of intelligent men, who, like himself, are always on the lookout for their own best interests and any dishonest methods or dark lantern processes will be destined to end in failure.

The foreman and his immediate subordinates, who are held responsible for results, must recognize the fact, especially if it be a large plant on which the eye of the management is continually centered, that the average general manager or superintendent of motive power is not a piece-work expert, and if he were, he has no time to look into details, and must necessarily hold his subordinate officers, such as general foremen, foremen of departments and gang foremen, responsible for the successful operation of the shop.

The master mechanic or general foreman who has kept pace with the times will not need to be told that, until very recently, in the discussion of this subject by the higher railroad officials at their association meetings about two out of every three were opposed to piece-work in any form in a repair shop, and many motive power officers are not yet willing to admit that this system of paying for work can be made successful in certain departments. So that, after all, the introduction of piece-work is a matter of education.

The foreman, then, must feel that if piece-work is introduced into his shop at all, it will be due almost entirely to his efforts; and whatever of success it is attended with, is properly to be credited to himself and the men in his charge.

In almost every day-work shop ninety out of every hundred men are opposed to piece-work. And why? Because they fear it will eventually result in a general reduction of their wages; that it will finally reduce the number of men employed in the shop and will at last either dispense with the services of the old men, or require them to work much harder at a reduced compensation.

This last named objection should be given careful consideration. The railroads of the country owe a debt of gratitude to their old employees. They should be taken care of and should not be required to work piece-work, except at their own request.

Mr. Carnegie, in his "Gospel of Wealth," argues that age is not a condition made by human institutions, and the right to weed out old men is decreed by natural law, which law, says he, "may be sometimes hard for the individual, but is best for the race, because it insures the survival of the fittest in every department." The privilege to carry out this idea may be necessary in the management of a private concern but any attempt to introduce piece-work with this end in view ought to be doomed to failure.

Some men never grow old, except in years, and in my experience I have frequently come in contact with employees who were on the downward march in life, who could take the piece-work prices of the average mechanic and very materially increase their day rate, and were glad of the opportunity to do so.

In another article on this subject, I shall attempt to show that it is not the unusual effort of the workman that brings about, both increase in the out-put of the shop and in the wages of the man, but the introduction of improved tools and a systematic method of handling the work.

But going back to the subject in hand, a very large part of all that has been read and heard by the man in the shop on the subject of piece-work in the past, has been to effect that it is detrimental to the best interests of the average mechanic; and it is a fact which we have to admit, that in many instances in the past, piece-work has been the means in the hands of unscrupulous and dishonest foremen to take advantage of honest workingmen in depriving them of a just reward for honest toil. Entire confidence, of the men, then, is the first thing necessary, and the intelligent foreman, or general foreman, or master mechanic, or superintendent of motive power, for that matter, if he would finally succeed in this work, will not be in any big hurry about putting a great number of prices into effect, but will go to work diligently to first win the confidence and good will of the men and bring about a general good feeling in the shop. And while this process is going on it is very essential that the foreman and those in charge of the various departments of the shop look about them and see if there are not a great many things that need to be given attention in order to insure better results, even on a day work basis. A careful inspection of the shop may disclose the fact that there is a great deal of material scattered about that ought to be in the scrap pile, or at least does not belong inside the shop. No good ever came from a dirty shop. Dirty, greasy machines; old castings, forgings, useless bolts, scrap and many other things that might be mentioned, if left lying about the shop, are demoralizing to the workmen and create an atmosphere of indifference, slovenly ways and expensive methods of doing the work.

One of the leading superintendents of motive power in this country once said to me while I was in his service, "Show me the conditions under which men work in any shop and I will tell you not only the quality of the work, but the cost as well." Therefore one of the first moves to make in preparing for the successful introduction of piece-work is to "clean up," and then "keep cleaned up." You must figure that when men are on a piece-work basis they have no time to climb over piles of useless material. They cannot work on engines to the best advantage with all kinds of unnecessary material in the way. Blocking lying about the floor. Old lagging, truck wheels, dome casings, driving wheels. scrap and all work as fast as taken down, where there is not a special department set aside for this work, must be kept cleaned away to allow the men to work to best advantage.

Cultivate among the men by precept and example a spirit of activity and energy. And the workman who wishes to forge to the front will show to his superiors that he delights in his work; that he is never so happy and contented as when busily engaged in the work of the shop.

"The first external indication of the dry-rot in men," says Dickens, "is a tendency to lurk and lounge; to do nothing tangible to-day, but to have an intention of performing a number of tangible things to-morrow or the day after."

The successful management of a large body of men, or any number of men for that matter, no doubt, depends largely on the personality of the foreman, but after all, the foundation of governing and being governed was laid centuries ago in that old rules of rules, "Do unto others as you would have others do to you." Justice must be the spirit that actuates and controls our movements. A broad appli-

tion of the spirit of right between man and man is the only thing that will pay 10 per cent. on the investment.

Men must understand that they are appreciated; that the success or failure of the institution is with them; that if success attends the operations of the shop, the credit will belong largely to the men in the ranks. "Too much still remains of the old idea that work is a curse, a punishment, instead of being the only real pleasure in life."

Every man has a right to make each day stand for something. In all the nooks and corners of human existence there is no place for an idler, or dreamer. It is better to carry a hod or wield a shovel in an honest endeavor to be of some use to the community than to be nursed in wealth and live off the toil of others. The man who sets himself earnestly at work, no matter what the sort of labor, dispels at once all the elements of discontent, doubt and envy and applies a sure remedy for that disease commonly known as the "blues." He takes a new lease of life, and the successful shop manager must educate his men to be energetic, industrious, active, always on the alert looking for some means of bettering the service.

Sir Walter Scott, writing to his son at school, said, "I cannot too much impress upon your mind that labor is the condition which God has imposed upon us in every station of life; there is nothing worth having that can be had without it." It is still water only that becomes stagnant and is finally covered with the green scum of inactivity. The running brook at all times sparkles with the living fire of usefulness.

To the master mechanic or general forman who contemplates the introduction of piece-work at some future date, let me suggest that if you have not already done so, there is no move which you can make which will so materially assist the sub-foreman in carrying out the above suggestions and so quickly instill new life into the entire shop, as the organization of a Shop Foremens' Association, to meet at stated periods, say once each month, to discuss means and methods of bettering conditions and increasing the out-put of the shop. It may be that changes will necessarily have to be made before you are in a position to consider piece-work at all, and there can be no better way of finding out just what the conditions are than by calling together and consulting those in immediate charge of the work.

(To be continued.)

HEAVY FREIGHT LOCOMOTIVE.

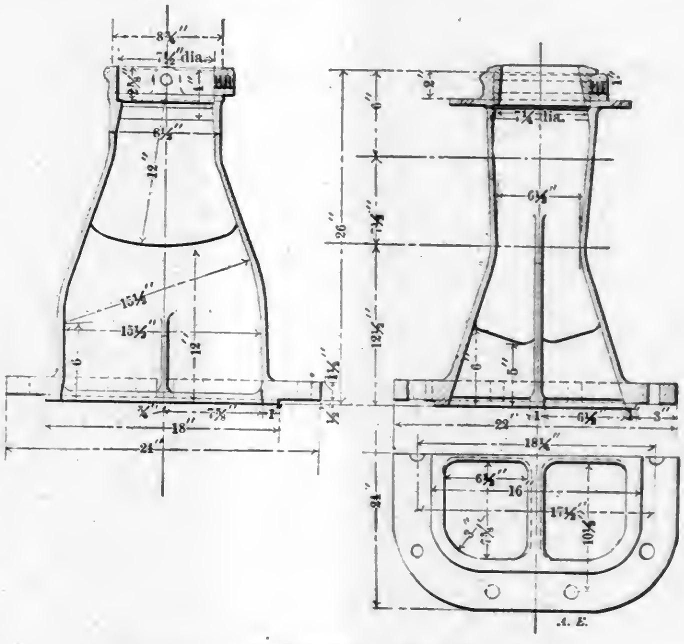
LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

2—8—0 TYPE.

SOME OF THE DETAILS OF CONSTRUCTION.

The previous article on this subject appeared on page 415 of the November number of this journal, and the description will require another article in addition to the present one. The design represents special efforts on the part of the mechanical officers of the road and of the American Locomotive Company to produce an engine which will materially reduce the number of "engine failures" in service.

The boiler of this engine was passed over rather too easily in the description last month. This is a very large boiler. Its diameter at the smoke box is 80 in., and at the largest diameter it is 87½ in., which is unusual. This large size was used at the throat connection, in order to facilitate the circulation by providing plenty of room for the water to pass back to the water legs. It is a pleasure to see these efforts in the direction of improvement in circulation of locomotive boilers. At best there is little enough room for water to get back to the side sheets. The tube spacing is wide, with a "bridge" of 15-16 in. between flues. The drop grates are



DETAILS OF THE FOUR-CHAMBER EXHAUST PIPE.

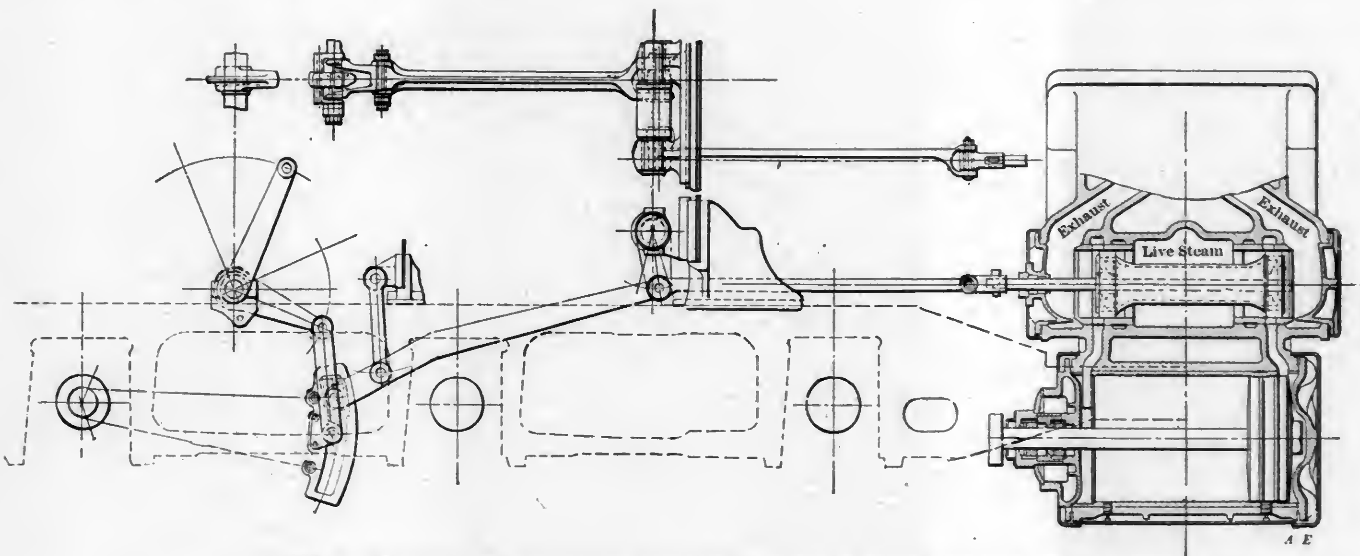


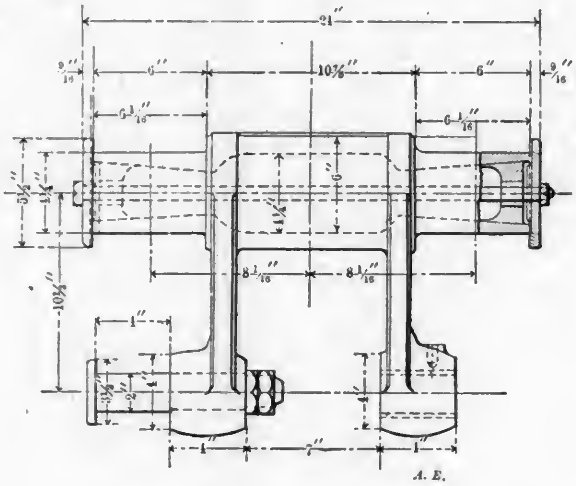
DIAGRAM OF VALVE GEAR AND VALVE, AND LONGITUDINAL SECTION THROUGH THE CYLINDER.

CONSOLIDATION (2-8-0) FREIGHT LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

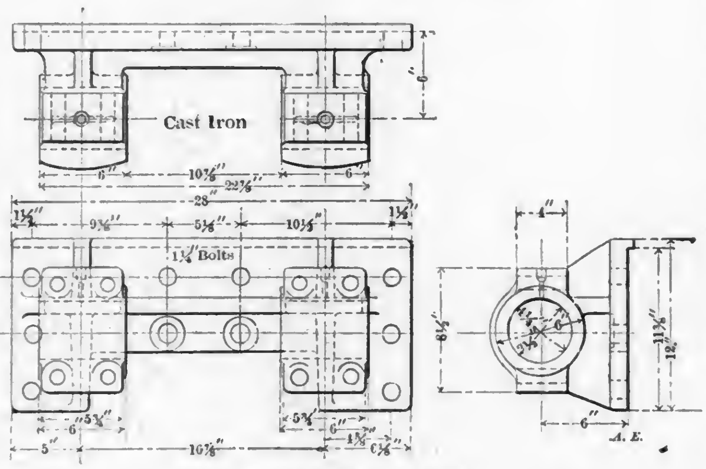
H. F. BALL, *Superintendent Motive Power.* American Locomotive Co., Brooks Works, *Builders.*

made as low as possible in order to secure space between the tubes and the level of the fire.

This locomotive has inside steam admission with very carefully arranged steam and exhaust passages, by using the Player four-chamber exhaust pipe the exhaust blasts are kept separate to a point 5 in. above the base of the exhaust nozzle, but this is not all. The exhaust steam passages are kept away from those containing live steam through the saddle, in order to prevent the exhaust from drawing heat away from the entering steam and causing initial cylinder condensation. A glance at the longitudinal section through the cylinder, shown in connection with the valve gear, shows these passages clearly. This is an important matter which does not always receive the attention it deserves.



THE HOLLOW TWO-BEARING ROCKER SHAFT.



DETAILS OF ROCKER BOX.

2-8-0 FREIGHT LOCOMOTIVE.—L. S. & M. S.

By aid of the drawing of the assembled parts of the valve gear, including the valve, the idea of the "central-direct" valve motion is illustrated. This construction is admirable. It places the pin as far as possible, in double shear, and by using a heavy and strong rocker casting the spring of this motion should be reduced to the lowest terms. The hangers are double. Obvious advantages are obtained by this construction. It will be noted that the English form of link is used and that the transmission bar is coupled to an inverted rocker, the rocker box being secured to the guide yoke and the rocker shaft has external bearings. This reduces the rocker box to a very simple casting, with two 4¼ by 6 in. bearings, with a space of 10⅞ in. between them. In order to reduce the liability of the rocker to twist, the two bearings were used and the rocker, made of cast steel, was given the form shown in the detail engraving, with the journaled portion made hollow. It is difficult to see how this rocker can twist or spring. Furthermore, the bearings are large and very easily taken down.

The valves are of the usual piston type as constructed at the Brooks Works, their general features having been illustrated in this journal.

Among the other details, which are specially worthy of close attention, are the frames and their bracing, the leading trucks and the ash pan. These will be reserved for another article, as it is specially desirable to place the frame construction on record in a thorough manner. These frames are the first coming to the attention of the writer in which an effort is made to provide for latent stresses. This work seems likely to prove to be exceedingly important.

OPERATIONS OF "PER DIEM" RULES FOR CAR HIRE.

Perhaps the most frequent objection made to the operation of per diem rules has been that the rules have not accomplished what the advocates of the per diem principles claimed they would; namely, the return of cars to owners, but, in the opinion of well-informed men, there is no per diem rate which can be established high enough to accomplish this purpose in all cases. When cars are not returned to owners, it is usually because there is a very active demand for them, or because the borrowing line is so seriously congested that it is physically impossible to make prompt return of cars. In either case, whether the rate be 20 cents a day or $1 a day, the return of the cars will not be forced.

Already, however, the rule has had very important results in compelling lines whose equipment was manifestly inadequate, to increase their equipment and compel lines that suffer not infrequently from serious congestion of traffic, to increase their facilities so that this congestion would not occur. Beyond question, per diem has stimulated representatives of railroads to the importance of moving cars promptly, and the justice of the position appeals to all men. In the past the railroads have not unfrequently been the worst offenders in the matter of detaining each others' cars. Not that I claim this was done intentionally, but that it was done because there was nothing to call attention to the importance of prompt movement. Now, however, railroads are treating themselves on what may be termed a "car service basis," and are in a better position to justify the charge for detention of cars by shippers and receivers of freight.

The strongest argument of the opposition to the per diem system was that the per diem rate would greatly increase empty mileage. In this they have certainly been mistaken, for this has not been noticed. The real difficulties in the operations of the rules, while not unimportant, require, as it seems to me, only a better understanding of these difficulties and the principles underlying the question to find a ready solution. From a paper by Mr. F. A. Delano, read before the Iowa Railway Club.

The floors of the new shops of the American Locomotive Company, at Schenectady, were very carefully laid and are quite satisfactory. The basis was a filling of sand over which from 4 to 6 ins. of small broken stone was laid. This was flushed with a gallon of hot coal tar for each square yard of surface. A course of 2 ins. of hot sand and tar mixed thoroughly to the consistency of mortar followed this and was rammed to a level surface. In this 3 by 4 ins. railing strips were imbedded at 3 ft. centers. Rough hemlock planks, 2 ins. thick, were spiked to these, and the top flooring of ⅞ ins. tongued and grooved maple was finally laid. It is an expensive but very satisfactory and permanent floor.

Col. James H. Bailey, who for the past 20 years, has been an owner and very influential in the *Railroad Gazette*, has severed his connection with that journal and retires from all active work. He had a very large and extensive acquaintance among the railway manufacturers of the country and will be very much missed, particularly at the railroad conventions.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

V.

VERTICAL DRILL PRESSES.

The ordinary vertical drill press in a locomotive repair shop has to handle drills, reamers, etc., varying from ¼ inch to 2½ inches in diameter; and the material to be drilled will vary from soft brass to the hardest cast iron or steel. Such a drill press, belt driven, usually has a back gear and a four-step speed cone, thus giving eight different spindle speeds for the entire speed range.

diameter, in order to present some idea of the wide range of speed which should be provided. By thus bringing out the great differences in speed required by drills of different diameters, it is clearly shown that the eight spindle speeds usually provided, are entirely inadequate if the best results are to be obtained. This point is emphasized even more when we consider that in place of three different materials, only, which are provided for in the above table, several more should be added when the different grades of iron and steel are taken into consideration, i. e., cast steel, machine steel, mild steel, cast iron, wrought iron, etc.

Unquestionably the application of a variable-speed motor to

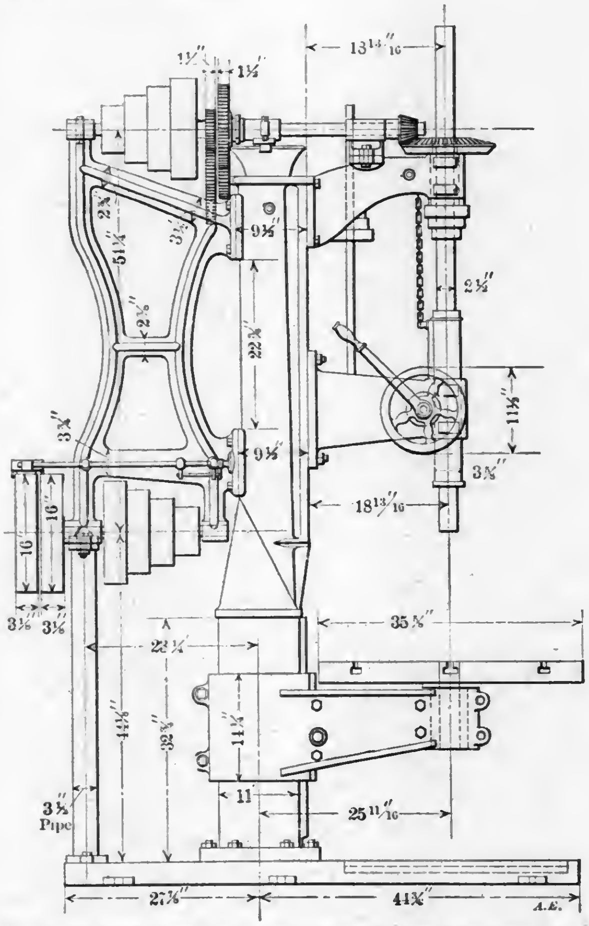


FIG. 21—STYLE OF THE OLD DRILL BEFORE REMODELING, FOR AN INDIVIDUAL DRIVE.

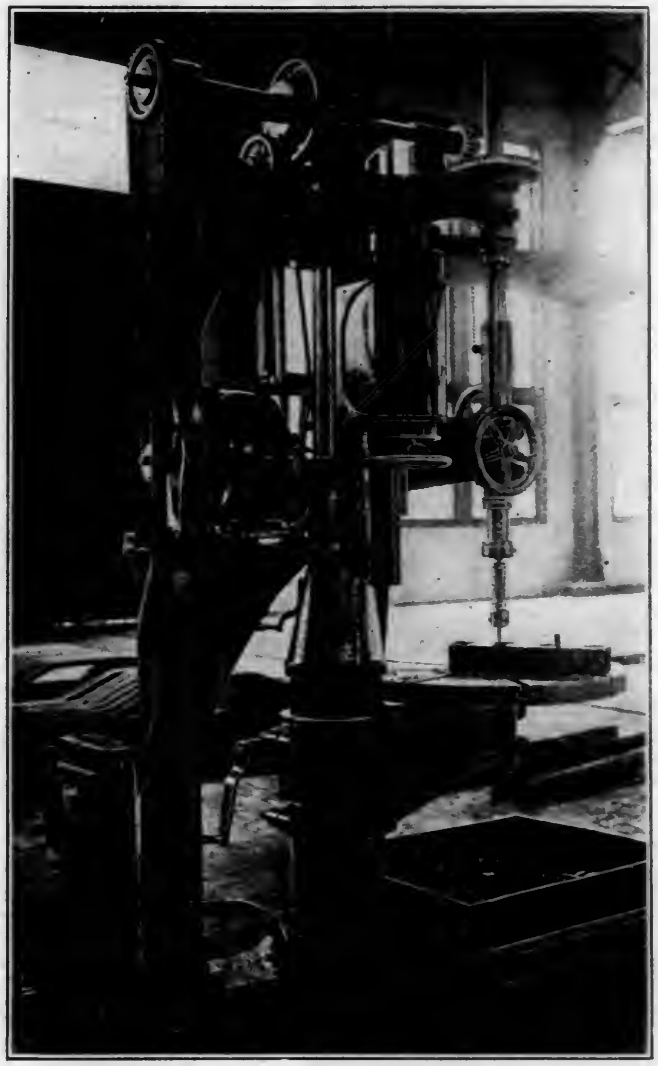


FIG. 22—APPEARANCE OF THE DRILL AFTER BEING EQUIPPED WITH THE CROCKER-WHEELER MULTIPLE-VOLTAGE DRIVE.

INDIVIDUAL DRIVING APPLIED TO OLD TOOLS.—PITTSBURGH & LAKE ERIE RAILROAD.

The following data are taken from the very complete table, found on page 957 of Kent's Mechanical Engineer's Pocket Book, giving the speeds for various diameters of twist drills as recommended by the Morse Twist Drill & Machine Co., and are presented to indicate the entire inadequacy of the ordinary drill press to meet the requirements for rapid drilling.

TABLE OF SPEEDS REQUIRED FOR TWIST DRILLS.

Diam. of Drills.	Speed, Rev. per Min. For Steel.	For Iron.	For Brass.
¼-in.	230	320	400
½-in.	115	160	200
¾-in.	75	105	130
1-in.	58	80	100
1¼-in.	46	62	80
1½-in.	39	54	66
1¾-in.	33	45	56
2-in.	29	39	49

The table from which this data is taken, gives the speeds required for all sizes, varying by sixteenths of an inch in diameter, but those above only are shown, for each ¼ inch in

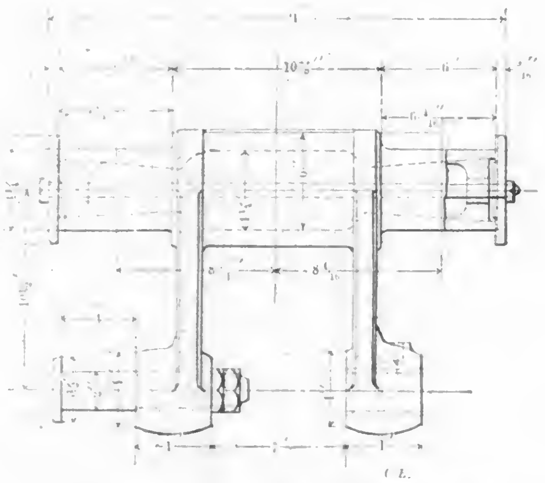
the drive of such a tool will prove a paying investment, since in place of the eight spindle speeds, when belt driven, we will have with the use of the variable-speed motor and a back gear, three or four times as many.

In Figure 21 is shown the type of the belt-driven vertical drill press, with 36-inch table, of which there were five in the old shops of the Pittsburgh & Lake Erie, at McKees Rocks. All were in good condition or such that a few repairs would make them so, so that it was decided to equip them with individual drives. The bracket which was used to carry the speed cones was so designed that it could not be used to support the motor, and it was replaced by a combination set of bracing and motor support brackets.

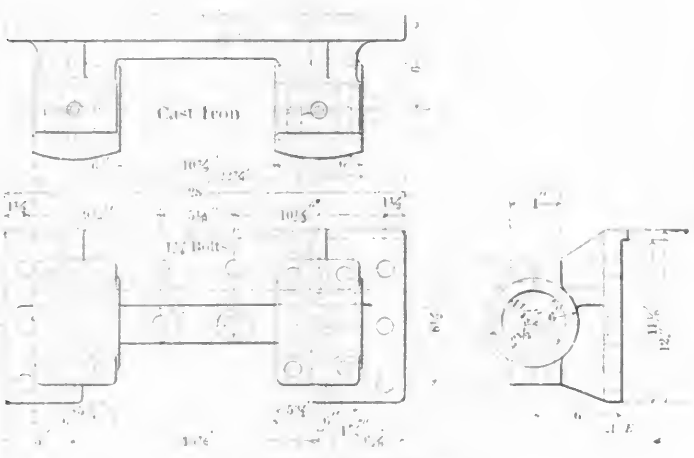
Figures 22 and 23 show the drill press as equipped with the new brackets and the variable-speed motor. The motor brackets were made quite heavy in order to add stiffness and strengthen the machine against vibration. The cone on the

made as low as possible in order to secure space between the tubes and the level of the fire.

This locomotive has inside steam admission with very carefully arranged steam and exhaust passages, by using the Player four-chamber exhaust pipe the exhaust blasts are kept separate to a point 5 in. above the base of the exhaust nozzle, but this is not all. The exhaust steam passages are kept away from those containing live steam through the saddle, in order to prevent the exhaust from drawing heat away from the entering steam and causing initial cylinder condensation. A glance at the longitudinal section through the cylinder, shown in connection with the valve gear, shows



THE HOLLOW TWO-BEARING ROCKER SHAFT.



DETAILS OF ROCKER BOX.

2-8-0 FREIGHT LOCOMOTIVE.—L. S. & M. S.

these passages clearly. This is an important matter which does not always receive the attention it deserves.

By aid of the drawing of the assembled parts of the valve gear, including the valve, the idea of the "central-direct" valve motion is illustrated. This construction is admirable. It places the pin as far as possible, in double shear, and by using a heavy and strong rocker casting the spring of this motion should be reduced to the lowest terms. The hangers are double. Obvious advantages are obtained by this construction. It will be noted that the English form of link is used and that the transmission bar is coupled to an inverted rocker, the rocker box being secured to the guide yoke and the rocker shaft has external bearings. This reduces the rocker box to a very simple casting, with two 4¼ by 6 in. bearings, with a space of 10¾ in. between them. In order to reduce the liability of the rocker to twist, the two bearings were used and the rocker, made of cast steel, was given the form shown in the detail engraving, with the journaled portion made hollow. It is difficult to see how this rocker can twist or spring. Furthermore, the bearings are large and very easily taken down.

The valves are of the usual piston type as constructed at the Brooks Works, their general features having been illustrated in this journal.

Among the other details, which are specially worthy of close attention, are the frames and their bracing, the leading trucks and the ash pan. These will be reserved for another article, as it is specially desirable to place the frame construction on record in a thorough manner. These frames are the first coming to the attention of the writer in which an effort is made to provide for latent stresses. This work seems likely to prove to be exceedingly important.

OPERATIONS OF "PER DIEM" RULES FOR CAR HIRE.

Perhaps the most frequent objection made to the operation of per diem rules has been that the rules have not accomplished what the advocates of the per diem principles claimed they would; namely, the return of cars to owners, but, in the opinion of well-informed men, there is no per diem rate which can be established high enough to accomplish this purpose in all cases. When cars are not returned to owners, it is usually because there is a very active demand for them, or because the borrowing line is so seriously congested that it is physically impossible to make prompt return of cars. In either case, whether the rate be 20 cents a day or $1 a day, the return of the cars will not be forced.

Already, however, the rule has had very important results in compelling lines whose equipment was manifestly inadequate, to increase their equipment and compel lines that suffer not infrequently from serious congestion of traffic, to increase their facilities so that this congestion would not occur. Beyond question, per diem has stimulated representatives of railroads to the importance of moving cars promptly, and the justice of the position appeals to all men. In the past the railroads have not unfrequently been the worst offenders in the matter of detaining each others' cars. Not that I claim this was done intentionally, but that it was done because there was nothing to call attention to the importance of prompt movement. Now, however, railroads are treating themselves on what may be termed a "car service basis," and are in a better position to justify the charge for detention of cars by shippers and receivers of freight.

The strongest argument of the opposition to the per diem system was that the per diem rate would greatly increase empty mileage. In this they have certainly been mistaken, for this has not been noticed. The real difficulties in the operations of the rules, while not unimportant, require, as it seems to me, only a better understanding of these difficulties and the principles underlying the question to find a ready solution. From a paper by Mr. F. A. Delano, read before the Iowa Railway Club.

The floors of the new shops of the American Locomotive Company, at Schenectady, were very carefully laid and are quite satisfactory. The basis was a filling of sand over which from 4 to 6 ins. of small broken stone was laid. This was flushed with a gallon of hot coal tar for each square yard of surface. A course of 2 ins. of hot sand and tar mixed thoroughly to the consistency of mortar followed this and was rammed to a level surface. In this 3 by 4 ins. railing strips were imbedded at 3 ft. centers. Rough hemlock planks, 2 ins. thick, were spiked to these, and the top flooring of ⅞ ins. tongued and grooved maple was finally laid. It is an expensive but very satisfactory and permanent floor.

Col. James H. Bailey, who for the past 20 years, has been an owner and very influential in the *Railroad Gazette*, has severed his connection with that journal and retires from all active work. He had a very large and extensive acquaintance among the railway manufacturers of the country and will be very much missed, particularly at the railroad conventions.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

V.

VERTICAL DRILL PRESSES.

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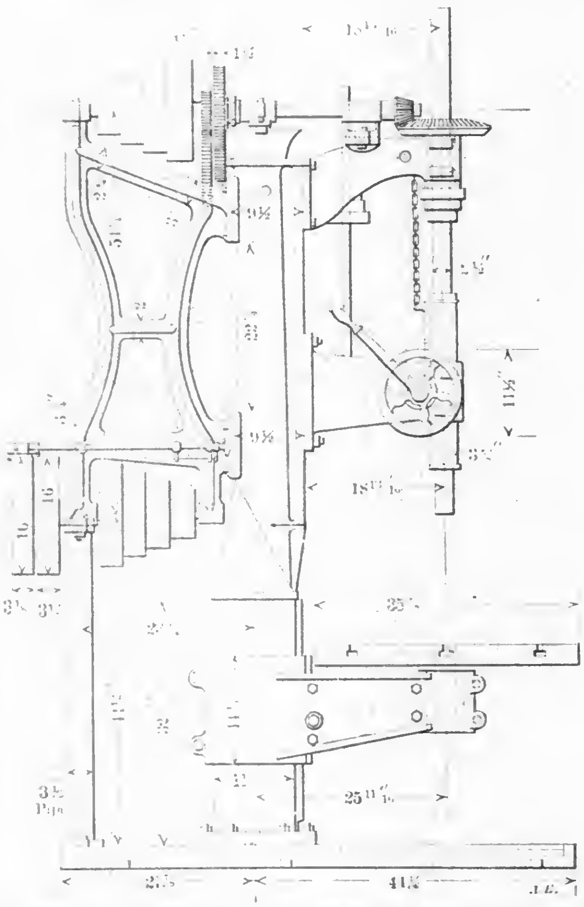

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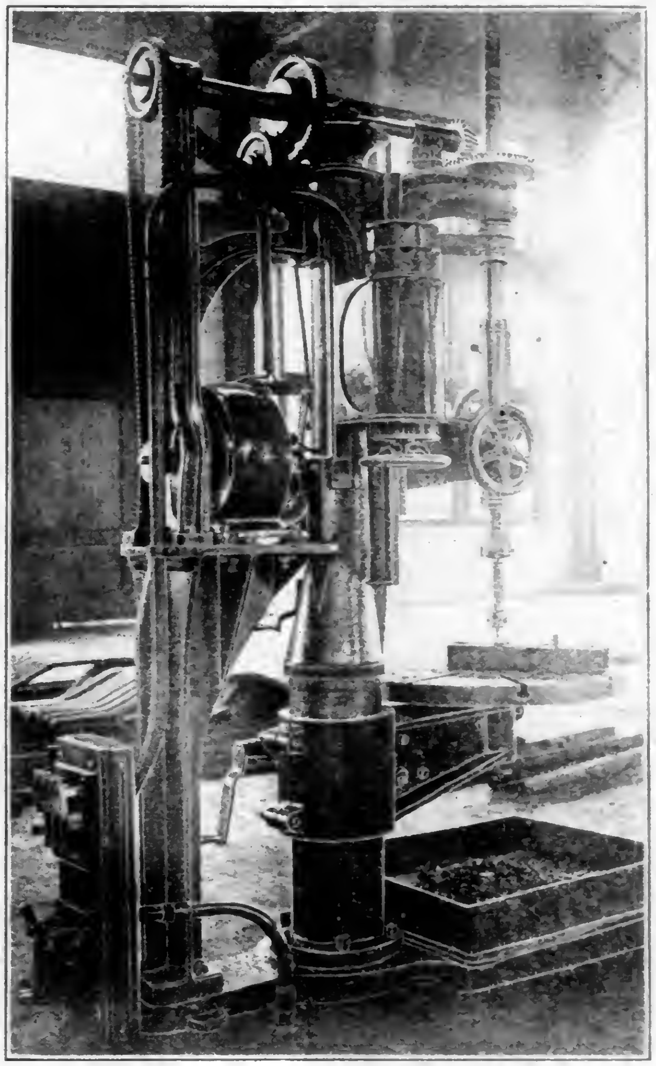

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Unquestionably the application of a variable-speed motor to the drive of such a tool will prove a paying investment, since in place of the eight spindle speeds, when belt driven, we will have with the use of the variable-speed motor and a back gear, three or four times as many.

In Figure 21 is shown the type of the belt-driven vertical drill press, with 36-inch table, of which there were five in the old shops of the Pittsburgh & Lake Erie, at McKees Rocks. All were in good condition or such that a few repairs would make them so, so that it was decided to equip them with individual drives. The bracket which was used to carry the speed cones was so designed that it could not be used to support the motor, and it was replaced by a combination set of bracing and motor support brackets.

Figures 22 and 23 show the drill press as equipped with the new brackets and the variable-speed motor. The motor brackets were made quite heavy in order to add stiffness and strengthen the machine against vibration. The cone on the

upper horizontal shaft was replaced by a sleeve, to the outer end of which is keyed the Morse Silent Chain sprocket, and to the other end of which is keyed a new gear, as indicated in Fig. 23, to replace the old one on the end of the cone. Also the old lock plate which is used for changing from back to single gear was added. In order to get the proper speed ratio, between the single gear and the back gear only two gears had to be changed as is shown in Fig. 23.

The motor is located high enough to be out of the way of dirt and metal cuttings, and yet is low enough to be easily accessible. It is also low enough to prevent the tool from being top-heavy with resultant excessive vibration. While running at the highest speeds, in single gear, the tool vibrates only slightly. The controller is placed in a convenient position so that the handle is within easy reaching distance of the operator, as shown in Fig. 23.

The question of the amount of power necessary to be provided at the motor, was a serious one. The difficulties which were at first met in adapting the high-speed tool-steels

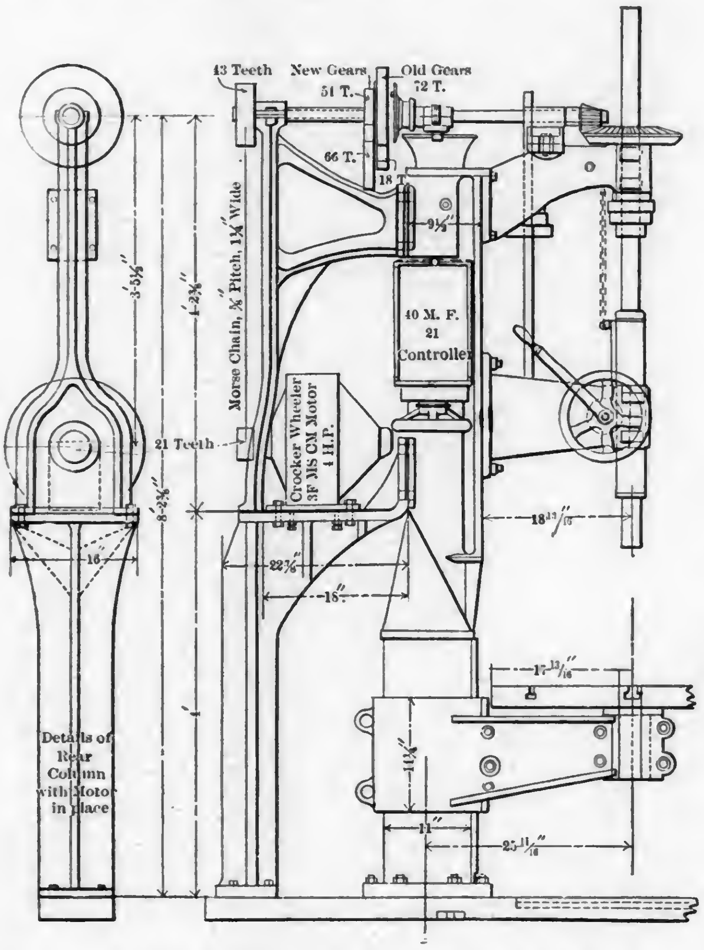


FIG. 23.—DETAILS OF THE TOOL AS EQUIPPED WITH THE NEW BACK BRACING AND THE ELECTRIC DRIVE.

to twist drills, are apparently being overcome, but as yet there seems to be no reliable information as to just what can be done with them. To provide for the possibilities of progress in this direction enough power was provided for to take care of the ordinary twist drill steel with a fair margin of reserve if a better steel should appear for such purposes.

The variation of power at the motor with the multiple voltage system of driving is indicated in the diagram, Fig. 25, which shows the motor horse-power available at the various drilling speeds that are provided at the spindle. This curve was plotted with the aid of the power diagram, presented in Fig. 1, (page 165, May, 1903 issue), which shows the relation between the speed and the power of a motor used with the M.-F. 21 controller, on the Crocker-Wheeler multiple-voltage system.

Since these drill presses have been equipped with motors, a rough series of tests have been made with drills up to 2 ins. in diameter, with the result that it was shown that ample power has been provided to take care of the ordinary grade of twist drill steel; also that a considerably better grade of steel, which would allow of the use of higher speeds, can be made use of without overloading the motor, except between speeds from 73 to 106 revolutions per minute.

The Crocker-Wheeler motors which are being used are, however, so designed that, if necessary, a considerable overload can be carried without injury. In the event of a higher speed

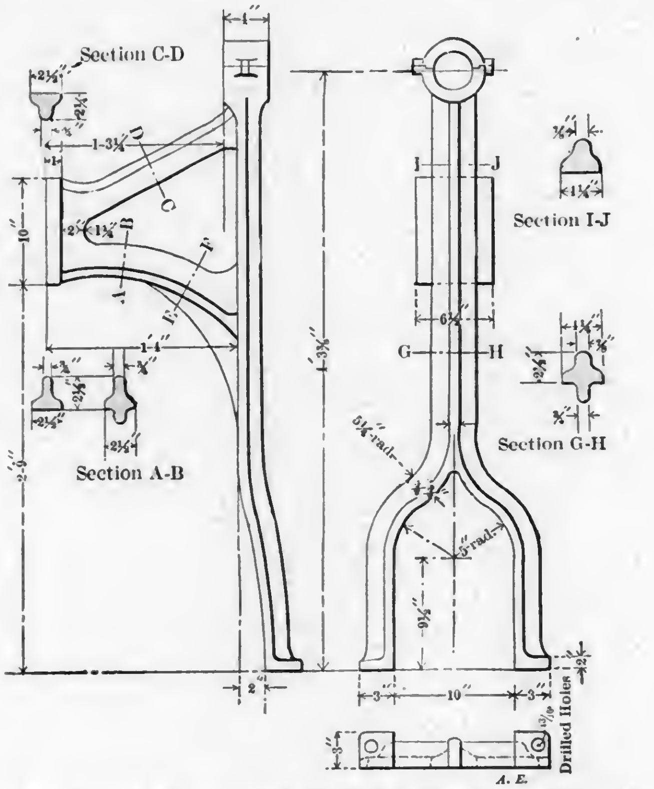


FIG. 24—DETAILS OF THE COMBINED BACK BRACE AND HORIZONTAL SHAFT SUPPORT.

steel being produced, which can be adapted to twist drills, and whose use with certain diameters of drills will cause the overload between the above mentioned speeds to be excessive, provision can be made for the use of such steel, by increasing the back gear ratio by replacing the two new gears, noted on

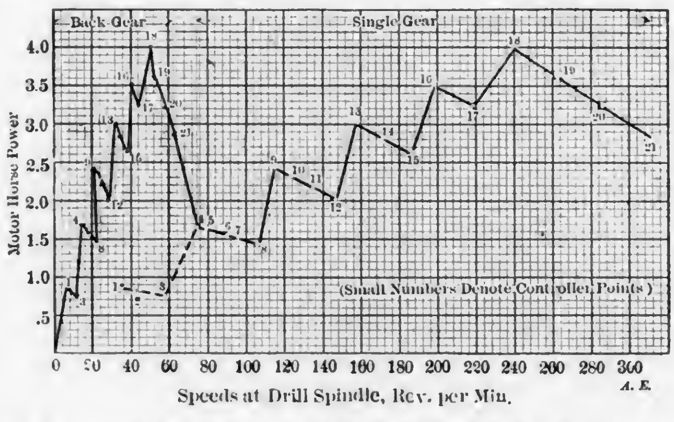


FIG. 25—DIAGRAM INDICATING VARIATION OF POWER AVAILABLE AT VARIOUS SPEEDS WITH THE MULTIPLE VOLTAGE SYSTEM OF DRIVING.

Fig. 22, with two others, so that the spindle speeds in back gear will still further overlap those in single gear.

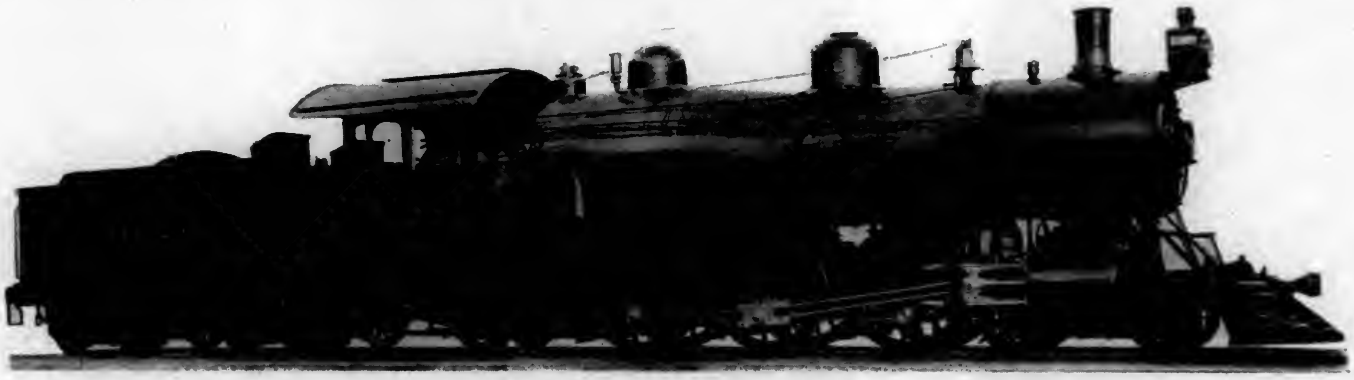
In providing power for drill presses, the largest diameter of drill which is to be used will govern the amount of power to be provided, since it has been found that the power required varies as the diameter of the drills, although not in the same ratio.

POWERFUL PASSENGER LOCOMOTIVE.

4-6-2 (Pacific) Type.

ATCHISON, TOPEKA & SANTA FE RAILROAD.

The Baldwin Locomotive Works have completed new locomotives of the 4-6-2, or Pacific type, for passenger service on the Atchison, Topeka & Santa Fe Railway. These are very heavy and powerful. They are simple engines with 22½ by 28 in. cylinders, 69 in. driving wheels, and carry 220 lbs. steam pressure. While being really as heavy as the very large passenger locomotives of the same type now running on the Chicago & Alton, illustrated on page 87 of our March issue, the heating surface is much less and the water spaces in the boiler larger. These are very powerful engines. Their chief dimension are as follows:



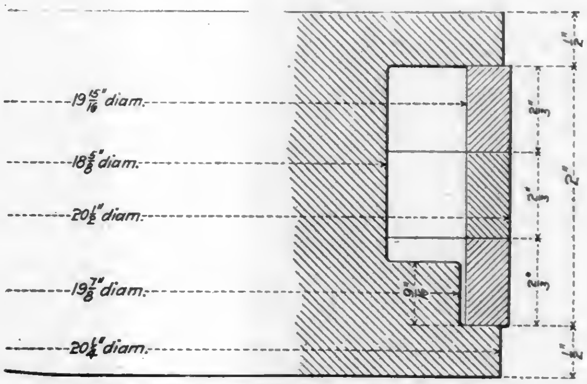
POWERFUL NEW PASSENGER LOCOMOTIVE.—ATCHISON, TOPEKA & SANTE FE RAILWAY.
4-6-2 TYPE. BUILT BY BALDWIN LOCOMOTIVE WORKS.

Ratios.	
Heating surface to volumes of cylinders	= 279.2
Tractive weight to heating surface	= 39.1
Tractive weight to tractive effort	= 3.66
Tractive effort × diameter of drivers, to heating surface	= 738.
Heating surface to tractive effort, per cent	= 9.35
Total weight to heating surface	= 59.85
General.	
Gauge	4 ft. 8½ ins.
Cylinder	22½ x 28 ins.
Valve	Balanced piston
Boiler.	
Type	Wagon top
Material	Steel
Diameter	70 ins.
Thickness of sheets	21-32 in., ¾ in. and 25-32 in.
Working pressure	220 lbs.
Fuel	Coal
Staying	Radial
Firebox.	
Material	Steel
Length	108 ins.
Width	71¼ ins.
Depth	Front, 78⅝ ins.; back, 68⅛ ins.
Thickness of sheets:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.
Water space	Front, 4½ ins.; sides, 5 ins.; back, 4 ins.
Tubes.	
Material	Iron
Wire gauge	No. 11
Number	290
Diameter	2¼ ins.
Length	20 ft.
Heating Surface.	
Firebox	122.8 sq. ft.
Tubes	3,402 sq. ft.
Total	3,595 sq. ft.
Grate area	53.5 sq. ft.
Driving Wheels.	
Diameter of outside	69 ins.
Diameter of inside	62 ins.
Journals	Main, 10 x 12 ins.; others, 9 x 12 ins.
Engine Truck Wheels.	
Front—Diameter	34¼ ins.
Journals	5½ x 10 ins.
Back—Diameter	40 ins.
Journals	7½ x 12 ins.
Wheel Base.	
Driving	13 ft. 8 ins.
Rigid	13 ft. 8 ins.
Total engine	33 ft. 9½ ins.
Total engine and tender	62 ft. 10½ ins.
Weight.	
On driving wheels	140,800 lbs.
On truck (front)	27,680 lbs.
On truck (back)	46,700 lbs.
Total engine	215,180 lbs.
Total engine and tender (about)	345,000 lbs.
Tender	
Wheels—Number	8
Tank—Capacity	7,000 gals.
Service	Passenger

SOLID RINGS AND SOLID PISTONS.

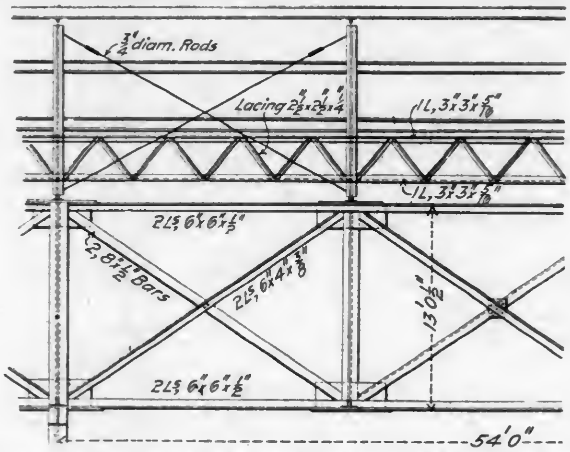
A great deal of interest has been aroused in England by a statement by Mr. A. F. Yarrow that for his engines he is using solid pistons and solid rings. *The Engineer*, of London, describes the construction and application of these rings. The construction is interesting and it could be used in many kinds of practice where high pressures are found. This would seem to be a good way to make packing for piston valves of locomotives. The following is quoted from a letter from Mr. Yarrow to the journal mentioned:

"Of course, at first sight it appears an impossibility to put the ring over the flange of the piston, the internal diameter of the ring being smaller than the outside diameter of the flange; but it is exactly the same thing as putting a half-crown through a hole the size of a shilling cut in a piece of paper. There is not the slightest difficulty in it. Of course, the rings have to be properly proportioned so as to get elasticity enough. I believe that having in view the early development of superheated steam, it becomes compulsory to have



A SOLID PISTON WITH THREE SOLID RINGS.

floating rings, and also compulsory that they should be uncut, so that any pressure of steam behind the ring should not press the ring against the inside of the cylinder. It has hitherto been thought that to have a solid floating ring one must have a junk ring, which adds weight and complication, and things that may work loose. A clearance of three or four or five thousandths of an inch is sufficient between the outside edge of the ring and the cylinder. A floating ring has the great advantage of accommodating itself to the form of a cylinder, which is not round throughout its whole length, as we all know, and in this respect the solid floating ring is very superior to the solid piston without any packing ring, which, of course, cannot accommodate itself to any ovaling of the cylinder."



DETAILS OF STEEL WORK FOR THE LONGITUDINAL BRACING OF THE BUILDINGS UPON CENTER LINES OF COLUMNS.

NEW LOCOMOTIVE AND CAR SHOPS.

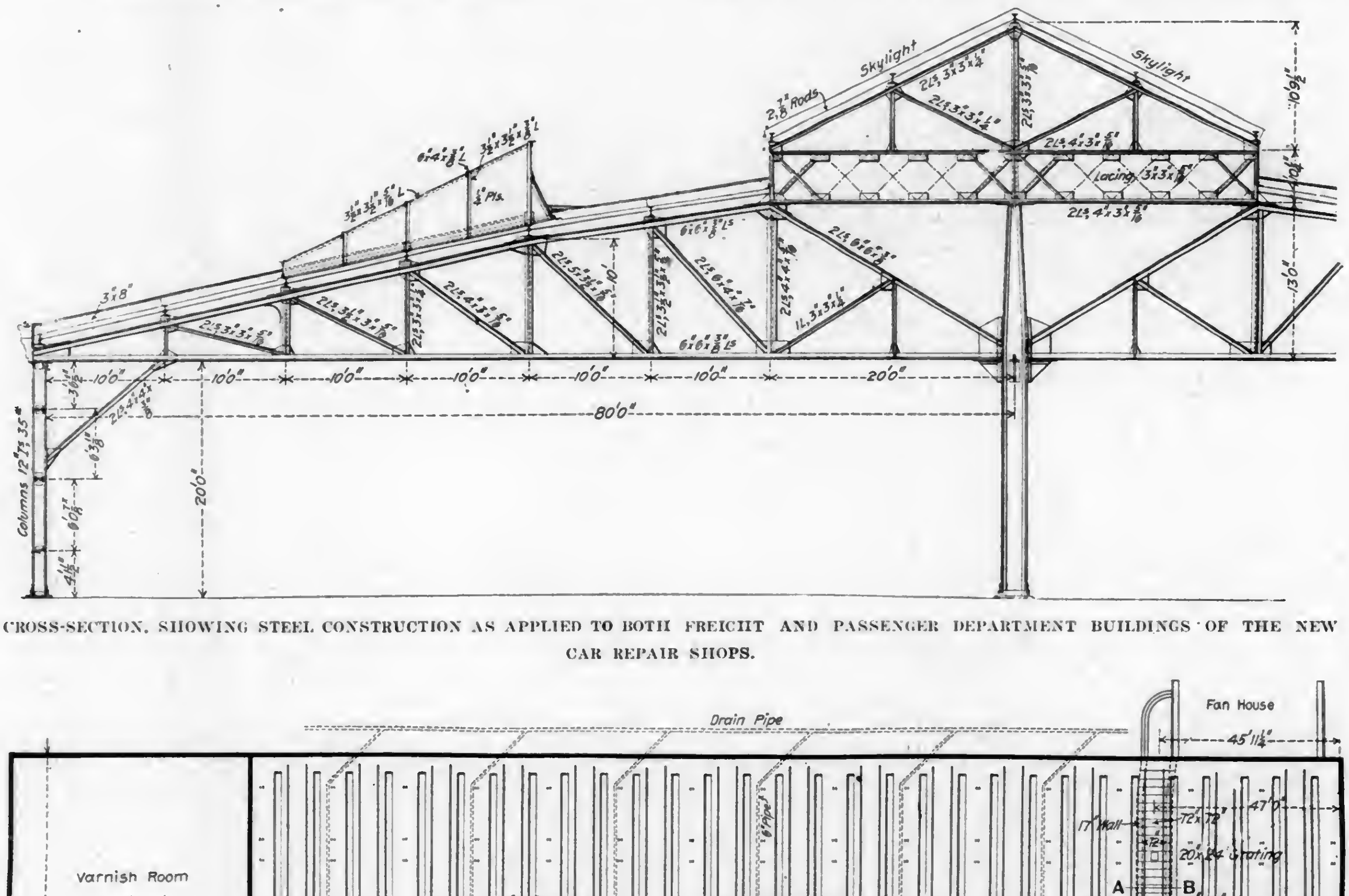
COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

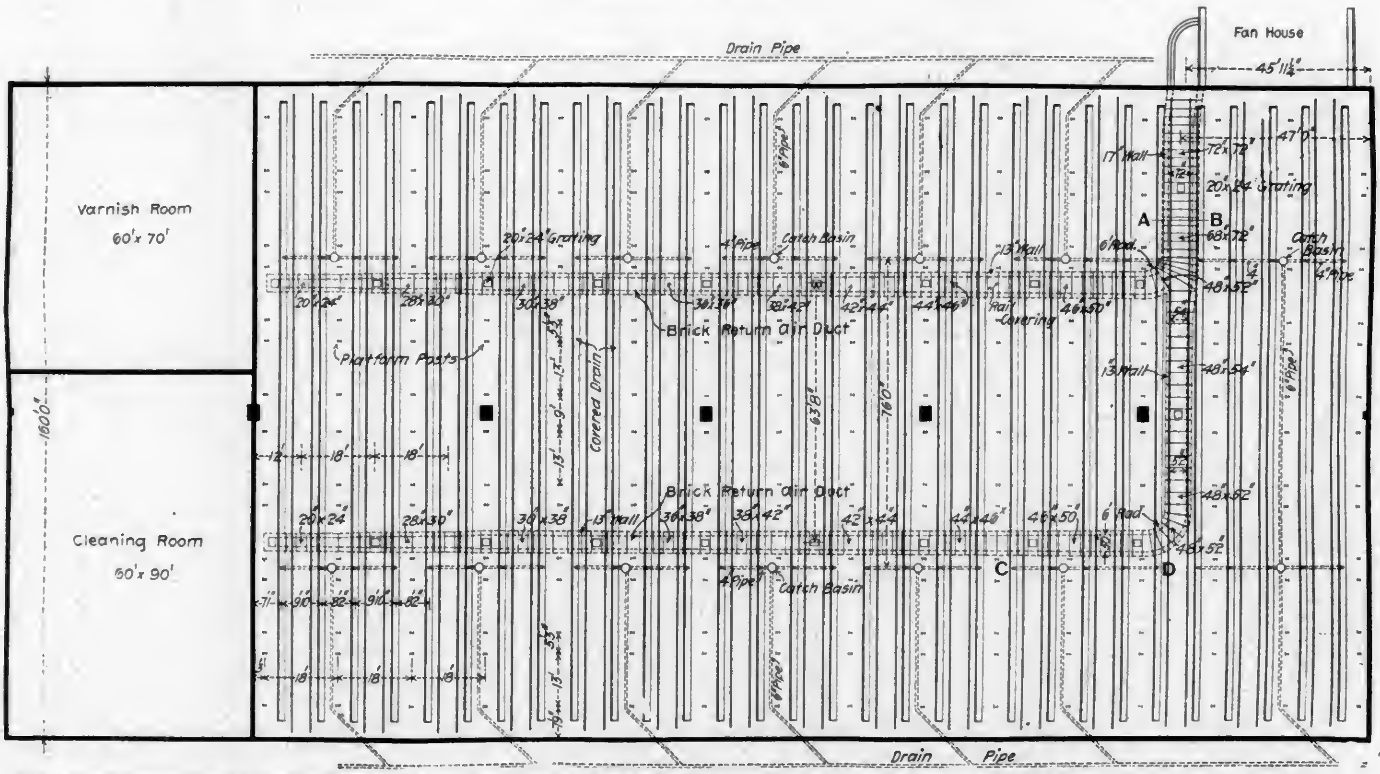
XIII.

CAR SHOP BUILDINGS.

These buildings are shown in the ground plan on page 408 They were designed by Mr. Albert Lucius, of New York, consulting engineer. The three principal buildings are arranged side by side and they are alike in their general features, such as the foundations, steel work and construction details, the only difference between them being in those features which must necessarily be varied to suit the special purposes to which each is put. For example the arrangement of the doors is



CROSS-SECTION, SHOWING STEEL CONSTRUCTION AS APPLIED TO BOTH FREIGHT AND PASSENGER DEPARTMENT BUILDINGS OF THE NEW CAR REPAIR SHOPS.



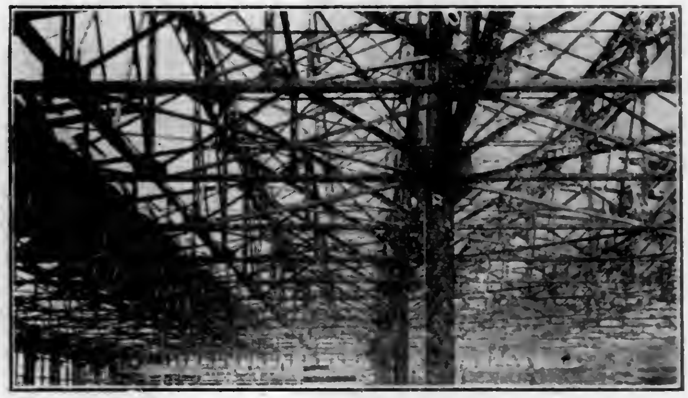
PLAN OF PASSENGER CAR PAINT SHOP, SHOWING ARRANGEMENT OF TRACKS, RETURN AIR DUCTS, DRAINS, PLATFORM POSTS, ETC.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

DETAIL VIEW OF THE NORTH END OF THE PASSENGER CAR PAINT SHOP.

VIEW OF THE NORTH END OF THE PASSENGER AND FREIGHT CAR REPAIR SHOPS.

DETAIL VIEW OF THE SOUTH END OF THE PASSENGER CAR PAINT SHOP.



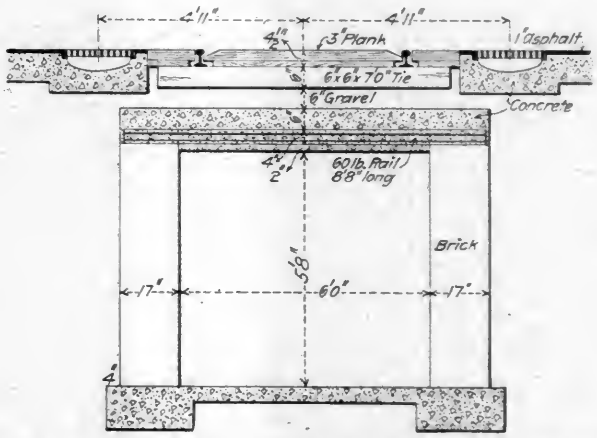
DETAIL INTERIOR CONSTRUCTION VIEW OF THE PASSENGER CAR PAINT SHOP.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

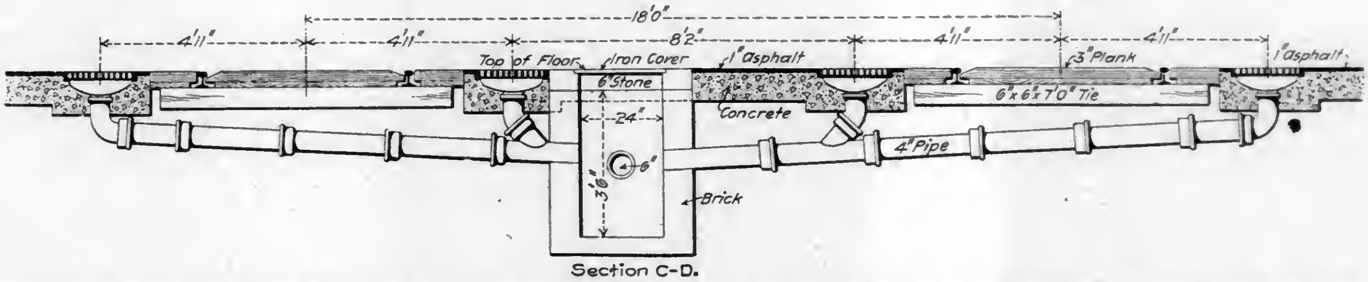
made to suit the tracks in each building and the amount of natural lighting is in accordance with the work which is done in each building. This feature of window and skylights is worthy of special attention. Better lighted buildings are very seldom, if ever seen in connection with railroad repair shops.

For example the total amount of glass in the sides and ends of the buildings amounts to 45 per cent. of the total areas of the walls and ends. The total glass area in these buildings is approximately equal to 75 per cent. of the total floor area. In the roof of the passenger car paint shop is a skylight, 42 ft. 4 in. wide by 245 ft. long in the monitor and to this is added 34 separate skylights 21 ft. by 11 ft. This gives an area of glass equal to 38 per cent. of the projected area of the roof. The passenger car repair shop has a skylight 22 ft. 4 in. by 335 ft. long, the full length of the building, and also 32, 11 by 11 ft, separate skylights, making 33 per cent. of the projected area of the roof. In the freight car repair shop, there is a skylight 37 ft. 4 in. by 333 ft. and 34 separate skylights, 12 ft. 3in. by 11 ft., making a total of 41 per cent. of the roof area. The planing mill has one 36 ft. 6 in. by 260 ft., making 45 per cent. of the roof area. In the photographs the large amount of glass area and its arrangement is clearly apparent. The sky lights are purposely given considerable rake in order to guard against leakage. This amounts to about one-quarter the height to the length of each skylight. This also applies to the monitor skylights and to this portion of the roofs of all the buildings, including the locomotive shops.

One cross section of the steel construction is illustrated.



SECTION A-B, THROUGH FLOOR AND RETURN AIR DUCT. (SEE PLAN.)



Section C-D.

SECTION OF FLOOR THROUGH ONE OF THE COVERED MANHOLES, SHOWING SYSTEM OF DRAINAGE BY TROUGHS, COVERED WITH GRATING, UNDER SIDES OF CARS. (SECTION C-D, SEE PLAN VIEW.)—PASSENGER CAR PAINT SHOP.

NEW LOCOMOTIVE AND CAR SHOPS.

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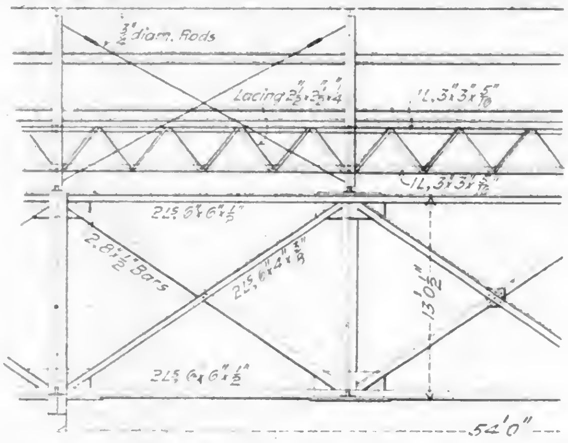
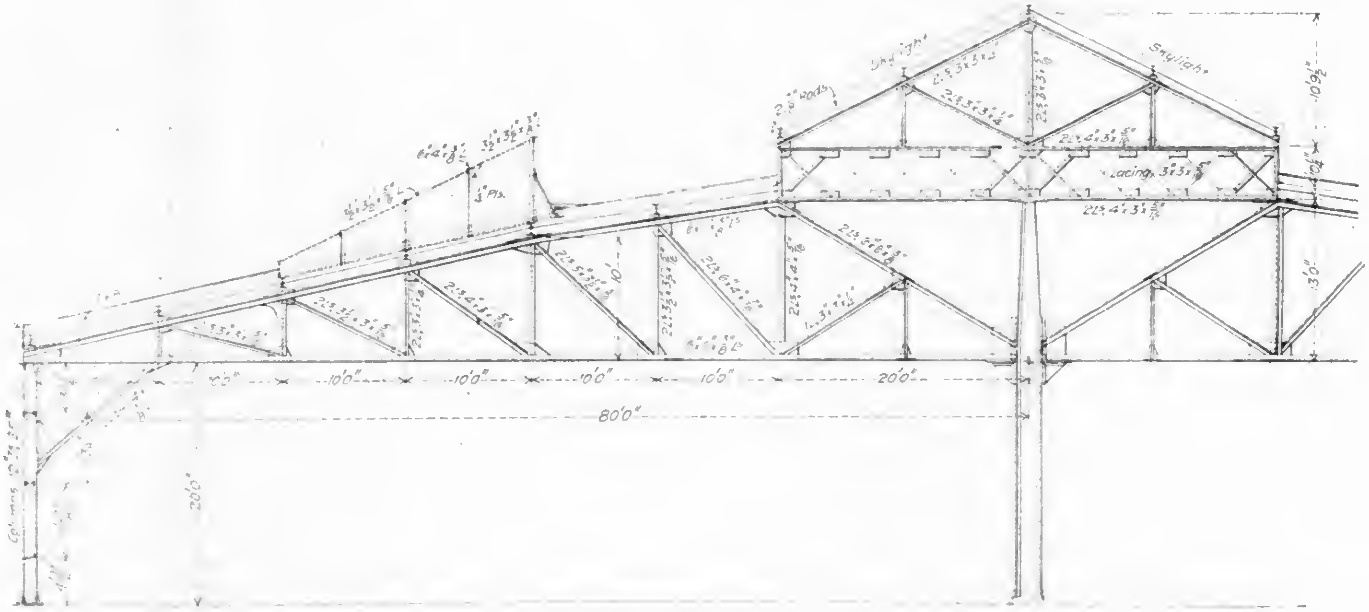
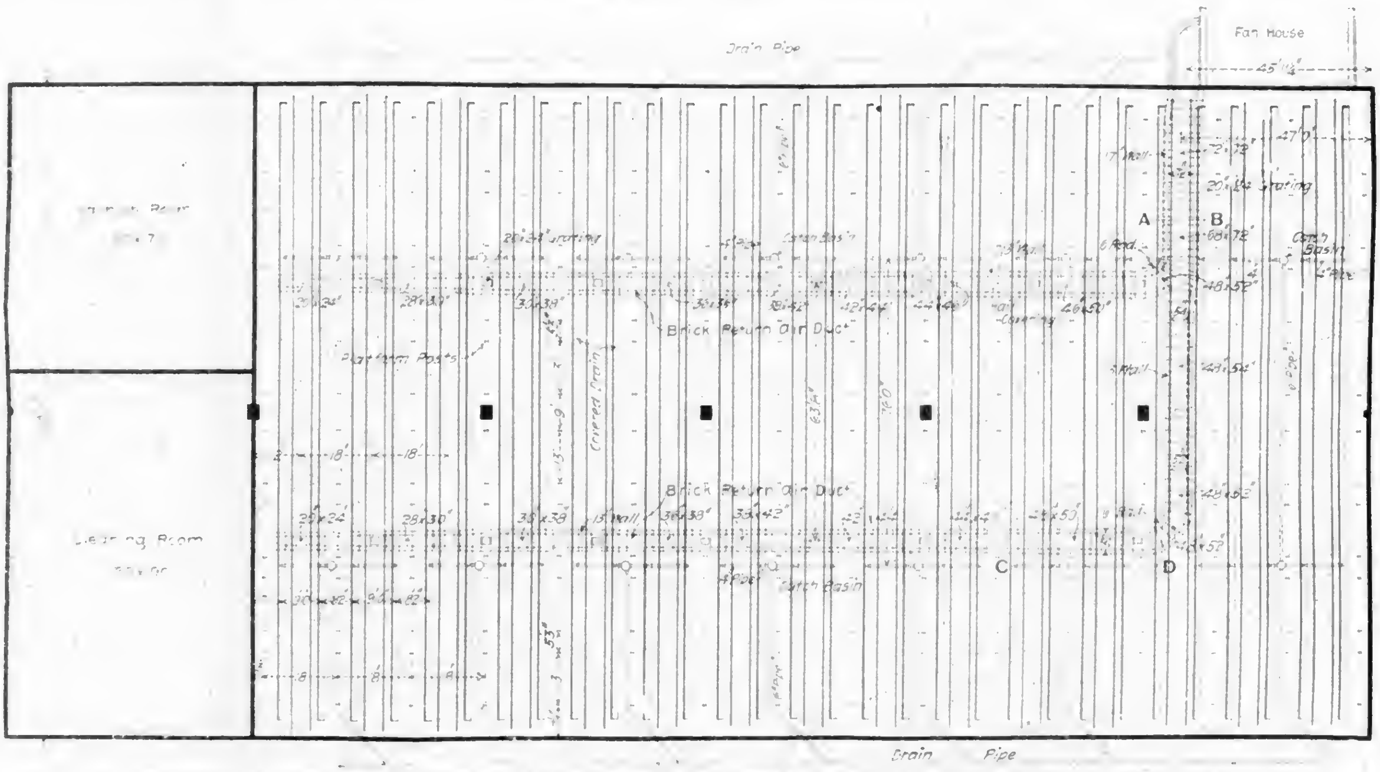


DETAILS OF STEEL WORK FOR THE LONGITUDINAL BRACING OF THE BUILDINGS UPON CENTER LINES OF COLUMNS.

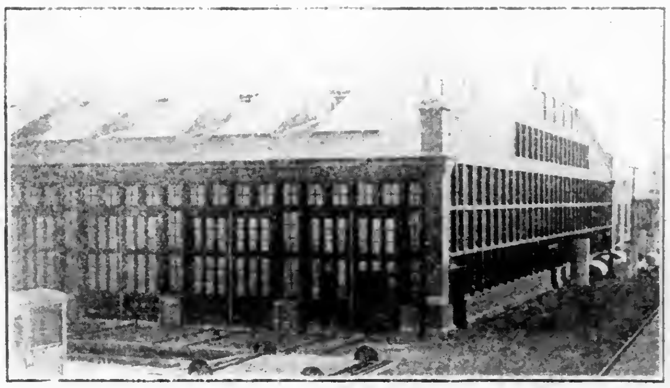


CROSS-SECTION, SHOWING STEEL CONSTRUCTION AS APPLIED TO BOTH FREIGHT AND PASSENGER DEPARTMENT BUILDINGS OF THE NEW CAR REPAIR SHOPS.

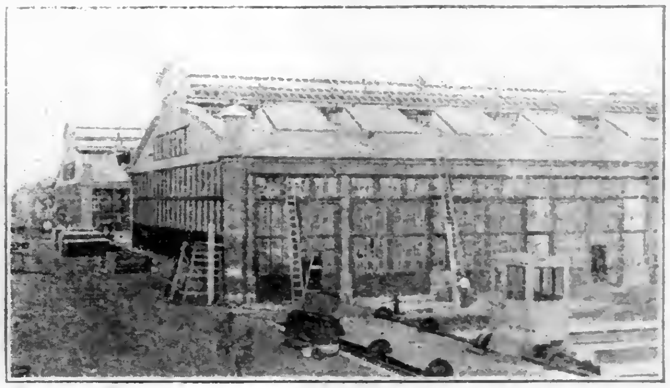


PLAN OF PASSENGER CAR PAINT SHOP, SHOWING ARRANGEMENT OF TRACKS, RETURN AIR DUCTS, DRAINS, PLATFORM POSTS, ETC.

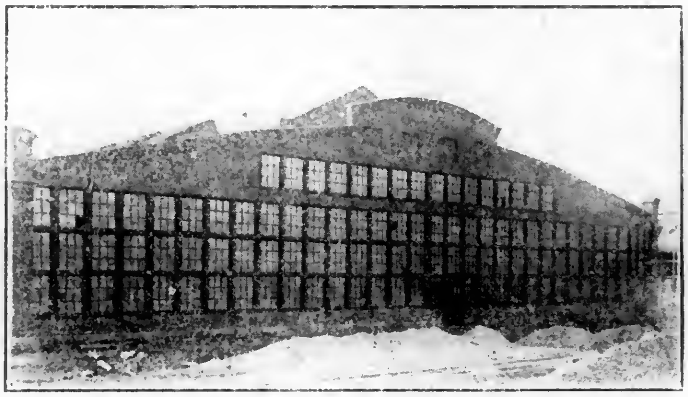
COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



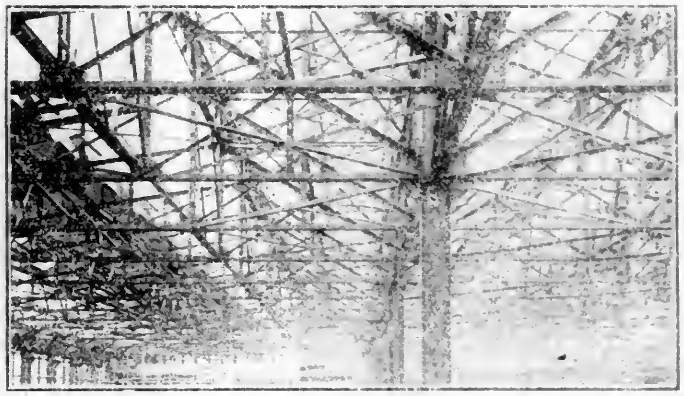
DETAIL VIEW OF THE NORTH END OF THE PASSENGER CAR PAINT SHOP.



VIEW OF THE NORTH END OF THE PASSENGER AND FREIGHT CAR REPAIR SHOPS.



DETAIL VIEW OF THE SOUTH END OF THE PASSENGER CAR PAINT SHOP.



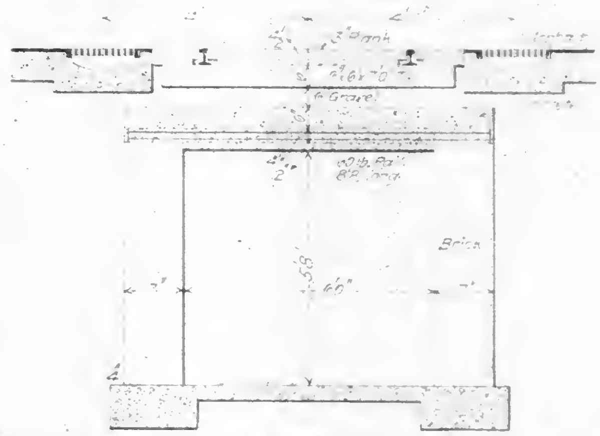
DETAIL INTERIOR CONSTRUCTION VIEW OF THE PASSENGER CAR PAINT SHOP.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

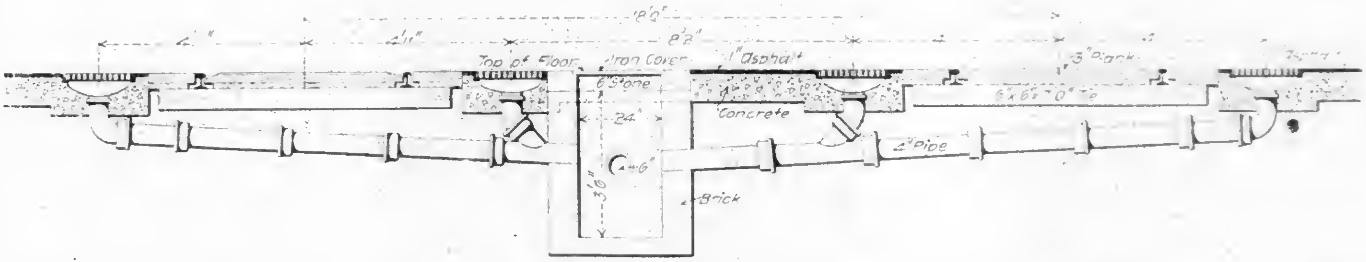
made to suit the tracks in each building and the amount of natural lighting is in accordance with the work which is done in each building. This feature of window and skylights is worthy of special attention. Better lighted buildings are very seldom, if ever seen in connection with railroad repair shops.

For example the total amount of glass in the sides and ends of the buildings amounts to 45 per cent. of the total areas of the walls and ends. The total glass area in these buildings is approximately equal to 75 per cent. of the total floor area. In the roof of the passenger car paint shop is a skylight, 42 ft. 4 in. wide by 245 ft. long in the monitor and to this is added 34 separate skylights 21 ft. by 11 ft. This gives an area of glass equal to 38 per cent. of the projected area of the roof. The passenger car repair shop has a skylight 22 ft. 4 in. by 335 ft. long, the full length of the building, and also 32, 11 by 11 ft. separate skylights, making 33 per cent. of the projected area of the roof. In the freight car repair shop, there is a skylight 37 ft. 4 in. by 333 ft. and 34 separate skylights, 12 ft. 3 in. by 11 ft., making a total of 41 per cent. of the roof area. The planing mill has one 36 ft. 6 in. by 260 ft., making 45 per cent. of the roof area. In the photographs the large amount of glass area and its arrangement is clearly apparent. The skylights are purposely given considerable rake in order to guard against leakage. This amounts to about one quarter the height to the length of each skylight. This also applies to the monitor skylights and to this portion of the roofs of all the buildings, including the locomotive shops.

One cross section of the steel construction is illustrated



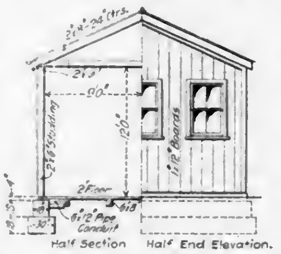
SECTION A-B, THROUGH FLOOR AND RETURN AIR DUCT. (SEE PLAN.)

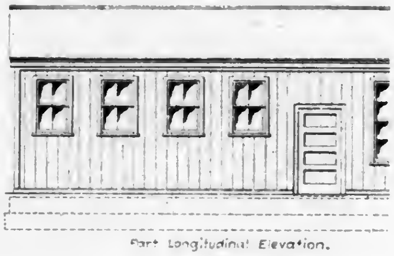


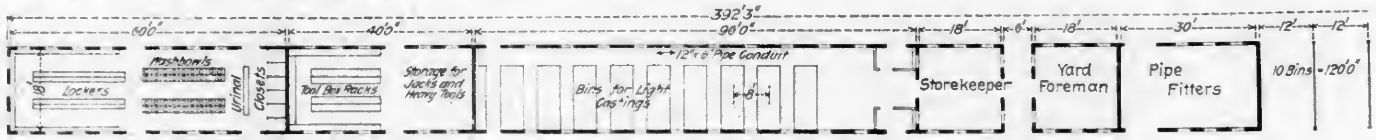
Section C-D.

SECTION OF FLOOR THROUGH ONE OF THE COVERED MANHOLES, SHOWING SYSTEM OF DRAINAGE BY TROUGHS, COVERED WITH GRATING, UNDER SIDES OF CARS. (SECTION C-D, SEE PLAN VIEW.)—PASSENGER CAR PAINT SHOP.

It represents all of the buildings. The center posts are built up of ½-inch plates, 24 in. wide, with four 6 by 4 by ½ in. angles placed 24 in. back to back. These are made wide in order to offer a large amount of wind resistance. Above the bottom chords of the roof trusses the posts taper off toward the top. At the walls the columns are of 12 in., 35 lb. I beams. The clear height under the roof trusses is 20 ft. and the roofs are particularly well braced against wind stresses, as indicated in the photographs, showing the steel work, before the construction was completed. The span on each side of the center posts







DETAIL PLAN AND ELEVATION OF OFFICE, STORAGE AND LAVATORY BUILDING IN THE CAR REPAIR YARD.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

is 80 ft. and the roof trusses are spaced at eighteen ft. centers. The middle columns being spaced at 54 ft. centers. The roofs are of the "umbrella" type except that of the wood mill. All of the roofs are deep, giving a good proportion to the size and height of the buildings.

The center posts are placed on base stones 16 in. thick by 3 ft. 9 in. square and these rest on huge concrete foundations, in which the anchor bolts are set. The side and end foundations consist of the water table stones, 20 in. wide by 16 in. thick, resting on 27 in. stone sills, placed on concrete foundations.

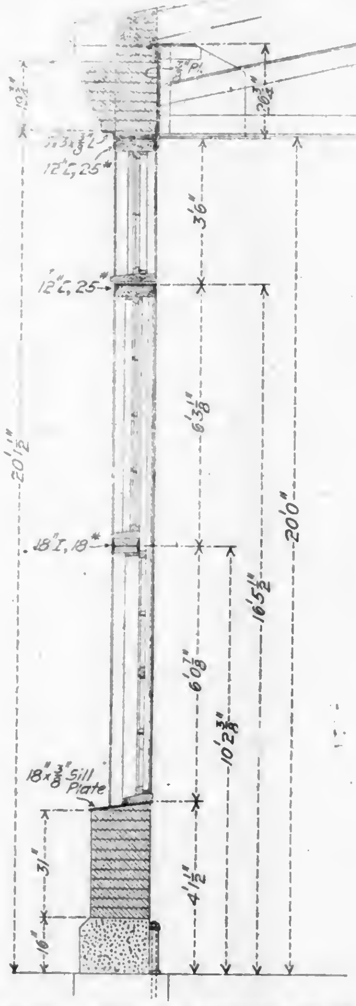
For ventilation the monitor is fitted with 18 in. louvres, its full length on each side, these being fitted with opening devices operated from the floors of the building.

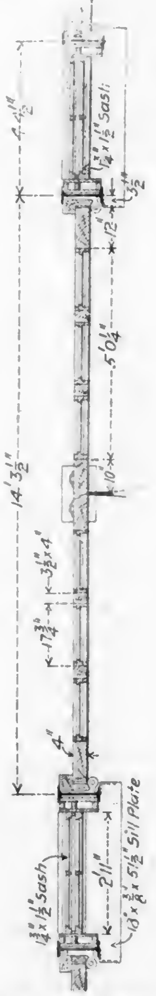
In connection with the plan view of the passenger car paint shop, a section of the floor and the drainage system is illustrated; this section is taken through one of the covered manholes. The plan shows the locations of the center posts, the tracks, the platform posts and the return ducts of the heating system, which are beneath the floor. The tracks are at 18 ft. centers and to this spacing all the depending features of the building are fitted.

Extending through the car repair yard, parallel to the tracks

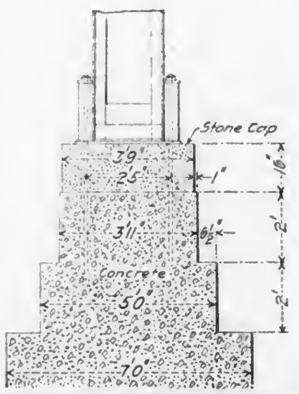
CONSTRUCTION VIEW OF THE PASSENGER CAR ERECTING SHOP. (FROM SOUTHEAST CORNER.

is a long low frame building, providing for the various small shops and storage spaces, necessary in a plant of this kind. The building has a span of 18 ft. and a clear height, inside, of 12 ft. Its total length is 392 ft. At the end toward the large shop buildings a 60 ft. lavatory space is provided. Next to this is a room 40 ft. long for the storage of tool boxes and heavy tools, such as jacks. Bins for light castings occupy a length of 96 ft. and the car yard storekeeper has an 18 ft. office at the end of this room. The remainder of the building provides an office for the yard foreman and a 30 ft. room for the pipe fitters. Beyond this are 10 bins for heavy castings, such as couplers, etc.

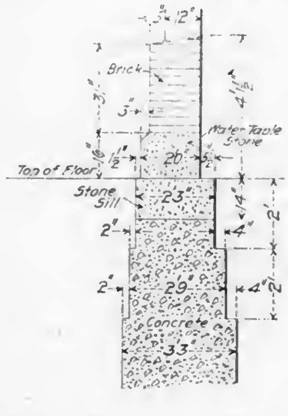




HORIZONTAL SECTION THROUGH SIDE OF BUILDING, SHOWING DETAILS OF WINDOWS AND DOORS, AND VERTICAL SECTION THROUGH WINDOWS.



SECTION THROUGH CENTER PIER FOUNDATIONS.



STANDARD SECTION FOR SIDE AND END FOUNDATIONS.

FOUNDATION DETAILS.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

THE USE OF FLY WHEELS UPON MACHINE TOOLS.

BY J. C. STEEN.

A fly wheel, or balance wheel, in use may be considered as a means of applying stored energy to a mechanism. The application of energy thus stored, must necessarily be of short duration. As a matter of course, work is required to set a balance wheel in motion, but the amount of power required to keep such a wheel in motion, after once being started, is, however, relatively small.

In machine tool practice there are cases where stored energy can be used to advantage: First: Where the work done requires a considerable amount of power for a short time—the punching machine is an example of this class; Second: The use of stored energy may be of benefit where there is a comparatively rapid reversal of some movable part—as the ram of a shaper or slotter; Third: Any machine tool, that has rotating members which must be quickly reversed as to their direction of rotation, may require for a brief period the use of stored or reserve energy—the metal planing machine is an example of this class. The above noted machines do not cover the entire field, but will serve as illustrations of the principle involved.

The application of this stored energy to a machine tool may be had in two ways: The driving belt and driving pulley will, and do, in some cases, act as a form of stored energy; in other cases the addition of a separate balance wheel, as an auxiliary to the belt, is necessary. To determine the point where the energy of the running belt is sufficient, or where the addition of a separate wheel is advisable, it is essential that all operating conditions of the machine be known and understood. That which will answer in one case, may be wholly inefficient in another; or, the use of that which means success in one case may be a superfluity in another.

An example may be of interest. Some years ago a shaping machine was built which had extra weight added to the driving cone to serve as a balance wheel. The reserve force, or storage of energy, thus obtained came into excellent use, when the machine was used upon short strokes with a heavy cut, but it was wholly insufficient when used upon long strokes as the reserve energy was too quickly exhausted. In this particular case the design of the machine rendered the use of a balance wheel necessary. In the first place, the driving belt was somewhat lighter than is now the practice for this type of machine, and second, the Whitworth driving motion was so arranged that the starting of the cut was quite abrupt. In this case, the balance wheel effect of the heavy pulley, besides being a benefit when the machine was used upon short heavy cuts, served to relieve the light belt of the shock due to abrupt start of the tool into the work.

Certain types of slotting machines were at one time made with a fly wheel added to the driving shaft. Both shaping and slotting machines are in use which have this feature as a part of the machine.

With the more modern designs of shaping and slotting machines, whatever is needed in the way of a "balance of power" is obtained by the use of a somewhat heavy driving pulley, and wider and heavier driving belt than was at one time the practice; also a larger ratio of driving gears is now used than formerly, and, as higher belt speeds are necessary, the balance wheel effect thus obtained is usually sufficient. Besides, with this type of machine, the driving motion is, or should be, so arranged that both the beginning and ending of the cut take place with a moderate speed, the maximum rate of speed being at the center of length of the cut. These features, if properly looked after in the design of the machine, render the addition of a balance wheel unnecessary.

The above consideration apply to what are known as crank driven machines. Rack-driven shapers and slotters can be considered, in a measure, as being of the same class as planing machines, in as far as the conditions of driving are concerned.

With the operation of a planing machine, the quick reversals of direction of rotation of the driving pulleys, shaft and gears, as well as the changes in direction of the platen itself, render necessary the applications of considerable power for short periods of time. These increased amounts of power required, may be, and in some cases are greater than that required for either taking the cut or moving the platen and its load in the return direction. The excessive power demands at moments of reversal have at times caused quite a lot of trouble in the wear of belts, due to the heavy strains put upon them; countershafts have been hard to hold; the driving of nearby machines has at times been rendered unsteady; belts soon lose some of their holding quality as they glaze, owing to slippage.

Trouble due to this cause did not come all at once. It has grown as the planing machine has developed and for a time the cause was not apparent to all. This recalls to mind an occurrence which took place in the drawing room of a certain machine tool builder: Certain trobles had been reported, regarding the driving mechanism of their planers. The question as to the cause came up and an argumentative war was carried on between two factions among the draftsmen. One side believed that the reversal of platen caused the difficulty, while the other side held that the reversal of the driving pulley and accompanying rotating parts was to blame for the trouble. (Of course, this all took place when the chief was temporarily absent from the room.) The decision reached, was, that the pulley, principally, and platen, only partially, was at fault. With this view the chief coincided.

The reverse of the platen was unusually quick and a modification helped somewhat. The driving pulleys were of a heavy pattern; these were materially lightened, and other alterations were made in driving mechanism and the countershaft pulleys for the drive of the machine were made quite heavy, all of which led to an improved condition, and to the disappearance of former troubles.

An attempt made to stop a rapidly rotating pulley and to bring it to a high speed in the opposite direction, will convince anyone that in many cases there is needed, for the time being, an excess of power above that required for the usual operation of the machine. At such a time, the driving belt from the main line to the countershaft of the machine, is subjected to an extra heavy load, which can be relieved by the use of a balance wheel upon the countershaft. And this constitutes the principal, if not the only advantage derived from a balance wheel under these circumstances.

The fact that the severe work required at reversal is due more to the pulleys than to the platen, seems to have been ascertained by several concerns within relatively close periods of time. A year or two after the discussion, above noted, took place, word came that another planer concern, while experimenting along the line of quick return of platen, had arrived at the same conclusion, that the pulleys and accompanying rotating parts required more power at reversal than did the platen.

As to just when, where and just how much of a balance wheel is needed, depends mainly upon the design of the machine. In this connection planers seem to be the chief disturbers. One type of machine has very light pulleys, and a comparatively low gear ratio, and with these, a balance wheel is not much needed. Another type of machine works under similar conditions, with wide belts running at moderate speed and operates well by having the countershaft pulleys heavier than usual. Still another type of planer has a high ratio of gears, narrow belts and consequent high speed of the pulleys; with such machines, experience has shown the advantage of a balance wheel in connection with the countershaft.

With the high-speed class there is usually some slippage of belts, and, while the slippage serves to modify the severity of reversal, it is rough on the belts. Whenever this slipping of belts occurs, there is auricular evidence that "something is doing." For many years, most of the planer builders have followed to a greater or less extent the practice of making at least one of the countershaft pulleys quite heavy to act as a balance wheel.

As to the use of balance wheels upon motor-driven planers

or similar machines, the benefit derived will depend somewhat upon the motor used, and here also the different types of machines will have influence. With the motor, the excess energy required at reversal may or may not be detrimental to its action. Some motors seem to be able to take care of an extra load, momentarily applied, with ease; while others spark and flash at the brushes and show their reluctance to taking on any extra load quite plainly. This unsteady movement of energy at the motor may cause irregular action elsewhere and be objectionable on this account. If a properly proportioned balance wheel can be applied so that a smoother and better action of motor will result, then its use will be of advantage. Local conditions therefore, must determine for individual cases, whether the use of a balance wheel is advisable or not.

The above is given, not as a treatise, nor as being exhaustive of the subject, but mainly in answer to questions that have been recently brought forward.

REDUCING BEARING SURFACE TO CURE HOT BOXES.

In investigating trouble with hot boxes on a road running into Chicago it was found that the bearings were in contact with the journals upon more than one-quarter of the circumference. By reference to this diagram it will be seen that if

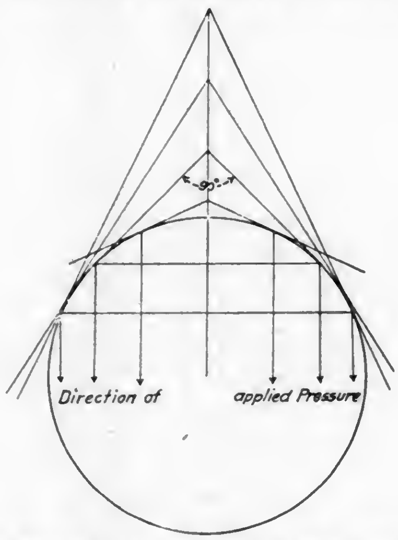


DIAGRAM INDICATING EFFECT OF TOO LARGE CONTACT BETWEEN JOURNAL AND BEARING.

the contact is one quarter of the circumference, the tangents will form an acute angle, and consequently scraping and gripping will occur at the edges if a heavy load is applied to such a bearing. This is likely to prevent the oil from reaching the bearing surfaces and cause heating. In this case the trouble was entirely overcome by removing the excess of bearing surface. There were no oil holes in these bearings and no grooves. In the original bearings several huge sized grooves did not reduce the heating at all. This subject is also fully treated in a paper, "A Review on Alloys," read before the Western Railway Club, April, 1902, by Dr. Gustave Thurnauer.

LOCKING DEVICE FOR CROSSHEAD PIN NUTS.

Michigan Central Railroad.

The device which is illustrated in the accompanying engraving is the interesting result of what might have been a very serious accident to one of the new 4—4—2 type passenger engines on one of the Michigan divisions of the Michigan Central Railroad. Considerable difficulty had been experienced with the nuts on the crosshead pins becoming loose, in spite of the fact that jam nuts were used. The accident finally occurred in which one of these engines lost out one crosshead pin due to the main and jam nuts, both working loose and dropping off; the result was a badly bent main rod from dropping out of the crosshead, but fortunately the engine did not leave the rails and no one was hurt—this was remarkable, as the train was, at the time, running at a high rate of speed.

This trouble is now provided for by the use of the locking discs, or plates, as shown in the engraving. This device consists merely of a disc of steel with a hexagonal opening to fit over the main nut, and several holes near its outer periphery, by which it may be fastened up against the crosshead. In applying the disc, it is merely slipped over the main nut after it is tightened, and is then bolted in position by the machine bolts as shown. The disc does not interfere with the jam nut which is put on as usual.

This very simple device has proved very effective and is now

A NOVEL LOCKING DISC FOR CROSS-HEAD PIN NUTS.—MICHIGAN CENTRAL RAILROAD.

being applied to all engines having crosshead pins of this type. We are indebted to Mr. D. R. McBain, master mechanic, and Mr. M. D. Franey, foreman, of the locomotive repair shops of the Michigan Central, at Jackson, Mich., for this information.

THE ORIGINATOR OF SLEEPING CARS

Colonel R. E. Goodell died, in Denver, October 21. He was a conspicuous figure in the railway world in the fifties. At that time he was superintendent of the Chicago & Alton Railroad, and it was he who executed, on behalf of the railroad company, the first contract ever made with the late George M. Pullman for Pullman sleeping cars. It was largely through Colonel Goodell's influence and sagacity that this first recognition of Mr. Pullman's sleeping cars was made which gave the "Alton" the distinction of being the pioneer sleeping car line. There were three different makes of sleeping cars originally submitted to Colonel Goodell for his choice, and after examining all patterns, the choice fell to Mr. Pullman. Colonel Goodell took Mr. Pullman to Bloomington, at which point the Chicago & Alton erecting shops then and now are located, and from two Chicago & Alton passenger coaches the first Pullmans were constructed. The first contract provided that the "C. & A." was to furnish the cars and keep up the outside, and that Mr. Pullman was to furnish and keep up the inside. While Mr. Pullman provided the drawings and patterns for his first cars, Colonel Goodell's recommendations, as the cars were under reconstruction, were exceedingly valuable to Mr. Pullman, and the friendship between the two men, formed at that time, continued until Mr. Pullman's death.

AN EXTENSIVE WATER SOFTENING INSTALLATION.

TOTAL CAPACITY, 348,000 GALLONS PER HOUR.

PITTSBURGH & LAKE ERIE RAILROAD.

II.

(*Continued from page 401.*)

The provision of good boiler waters is of the first importance as an operating problem. To be sure the question of economy in repairs is also important. On such a road as the Pittsburg & Lake Erie with an enormous and exacting traffic centering in such a city as Pittsburgh, the first requisite of the locomotive is that it shall be powerful and that its power shall be continuously available for service. Large capacity has been sought in some cases by merely increasing the dimensions and weights of engines, but this plan soon reaches physical limits and it does not avoid the loss of service because of boiler repairs due to bad water. When the water question is satisfactorily solved the matter of ultimate capacity may be taken up and water which is good for small boilers is also good for large ones. The plan of this road seems to be admirable because it promises to secure the utmost boiler capacity combined with continuous service of the present equipment, and furthermore, all other efforts to increase capacity are still available. Any principle tending toward obtaining the maximum possible results from present equipment appeals to us as right from a business, as well as from an engineering, standpoint and water purification seems to be the problem to which motive power and engineering talent can be most profitably applied at this time.

It is difficult to realize fully the extent to which the use of natural waters, containing scale-forming impurities, for locomotive water supply, influences the problem of caring for and maintaining locomotive boilers upon our railroads. The difficulties imposed by the formation and accumulation of scale upon the heating surfaces of boilers have, through the many years of use of steam power, come to be regarded as a necessary evil which cannot be avoided and which must be regularly provided for with care. It is the usual practice of most of our railroads to liberally provide for frequent and extensive boiler repairs and renewals, but the extra expense involved in this element of maintenance is incapable of exact determination on account of the complication and inter-connection of details—it is the experience, however, of all motive power officials that this element is very expensive and involved, and has been considered an unavoidable factor in the problem of locomotive maintenance.

The possibilities for economies that exist in the use of the water treatment system for removing the scale-forming impurities from the boiler-feed water, are thus almost beyond comprehension. Few have given this subject the consideration that it deserves and little is known, also, of the benefits to be derived. This subject was investigated with great care and analyzed most completely by the management of the Pittsburgh & Lake Erie Railroad under the direct supervision of the Engineering Department. Some of the considerations which led to the adoption of water purifying plants on a large scale on this progressive road may be of interest.

On account of the use of scale forming waters, and also of water containing free sulphuric acid, it will be admitted that bad results will inevitably come. These results may be summed up as follows:

First: Loss of fuel due to the insulating effect of scale on the flue and other heating surfaces.

Second: Loss in service of locomotives due to time required for making repairs, weekly, monthly and annually, directly chargeable to bad water conditions.

Third: Additional round house and shop expenses, due to the above work, for material and labor.

The above items will, of course, have different money values on different roads varying with the conditions; but on the Pittsburgh and Lake Erie the amounts have been estimated as stated below:

First Item: "Loss of fuel due to effect of scale, etc.":

A great deal of careful investigation has been given to the determination of the efficiency of the heating surfaces of boilers when clean and when coated with scale, and, in this connection the remarkable uniformity of the results of all such investigation is worthy of note.

In Clark's "Steam Engine," volume 1, page 218, it is stated that "a scale of a sulphate of lime 1-16 in. thick reduced the efficiency 14.7%" (as determined in a series of experiments upon a boiler). Dr. J. C. Rogers states, in the volume entitled, "Water Purification," that a scale 1-16 in. thick makes 15% more fuel necessary than with clean heating surfaces and furthermore that this ratio increases as the scale thickens. This authority also estimates the heat conductivity of boiler incrustation to bear a relation to that of wrought iron plate of 1 to 37.5. The authority, Rankine, states in his work on "Steam Engines" that the specific heat of carbonate of lime is 18 times that of iron, and that of sulphate of lime is 15 times that of iron; it is stated that the consequent waste in urging a fire for steam raising in a scaled boiler is enormous, as it is estimated that 1-16 in. of scale requires the use of 16% more fuel, while a scale ¼ in. thick will necessitate 50% more fuel, and ½ in. of scale 150% more fuel. A noted foreign authority, Fischer's Chemisch Technologie des Wassers, page 216, states that Reuben Wells ran two engines for several months with heating surfaces covered with scale and an equal length of time later with clean heating surfaces, and found a saving of 17½% with the clean boiler.

The remarkable uniformity of these few of the many tests that have been made in this direction tend to verify the general proposition that 1-16 in. of scale on the heating surfaces of a boiler will increase the fuel required to be burned to maintain a given temperature on the water side of the surface by approximately 14% to 17%—say 15%.

By careful investigation it has been determined that the average condition of a boiler will show at least ⅛ of an inch of scale upon the heating surfaces. The nature of the scale that forms in the boilers may be judged from the accompanying photographs of sections of boiler tubes that were selected

SAMPLES OF SCALED BOILER TUBES, TAKEN FROM LOCOMOTIVES OF THE PITTSBURGH & LAKE ERIE RAILROAD, AFTER 12 MONTHS OF SERVICE WITH THE UNTREATED WATER.

or similar machines, the benefit derived will depend somewhat upon the motor used, and here also the different types of machines will have influence. With the motor, the excess energy required at reversal may or may not be detrimental to its action. Some motors seem to be able to take care of an extra load, momentarily applied, with ease; while others spark and flash at the brushes and show their reluctance to taking on any extra load quite plainly. This unsteady movement of energy at the motor may cause irregular action elsewhere and be objectionable on this account. If a properly proportioned balance wheel can be applied so that a smoother and better action of motor will result, then its use will be of advantage. Local conditions therefore, must determine for individual cases, whether the use of a balance wheel is advisable or not.

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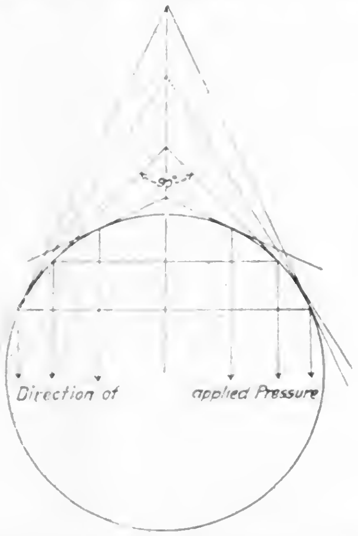


DIAGRAM INDICATING EFFECT OF TOO LARGE CONTACT BETWEEN JOURNAL AND BEARING.

the contact is one quarter of the circumference, the tangents will form an acute angle, and consequently scraping and gripping will occur at the edges if a heavy load is applied to such a bearing. This is likely to prevent the oil from reaching the bearing surfaces and cause heating. In this case the trouble was entirely overcome by removing the excess of bearing surface. There were no oil holes in these bearings and no grooves. In the original bearings several huge sized grooves did not reduce the heating at all. This subject is also fully treated in a paper, "A Review on Alloys," read before the Western Railway Club, April, 1902, by Dr. Gustave Thurnauer.

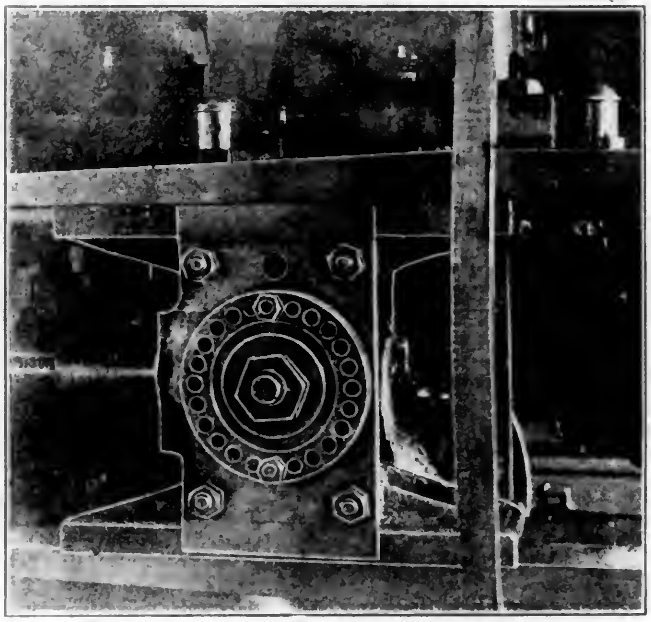
LOCKING DEVICE FOR CROSSHEAD PIN NUTS.

Michigan Central Railroad.

The device which is illustrated in the accompanying engraving is the interesting result of what might have been a very serious accident to one of the new 4—4—2 type passenger engines on one of the Michigan divisions of the Michigan Central Railroad. Considerable difficulty had been experienced with the nuts on the crosshead pins becoming loose, in spite of the fact that jam nuts were used. The accident finally occurred in which one of these engines lost out one crosshead pin due to the main and jam nuts, both working loose and dropping off; the result was a badly bent main rod from dropping out of the crosshead, but fortunately the engine did not leave the rails and no one was hurt—this was remarkable, as the train was, at the time, running at a high rate of speed.

This trouble is now provided for by the use of the locking discs, or plates, as shown in the engraving. This device consists merely of a disc of steel with a hexagonal opening to fit over the main nut, and several holes near its outer periphery, by which it may be fastened up against the crosshead. In applying the disc, it is merely slipped over the main nut after it is tightened, and is then bolted in position by the machine bolts as shown. The disc does not interfere with the jam nut which is put on as usual.

This very simple device has proved very effective and is now



A NOVEL LOCKING DISC FOR CROSS-HEAD PIN NUTS.—MICHIGAN CENTRAL RAILROAD.

being applied to all engines having crosshead pins of this type. We are indebted to Mr. D. R. McBain, master mechanic, and Mr. M. D. Franey, foreman, of the locomotive repair shops of the Michigan Central, at Jackson, Mich., for this information.

THE ORIGINATOR OF SLEEPING CARS

Colonel R. E. Goodell died, in Denver, October 21. He was a conspicuous figure in the railway world in the fifties. At that time he was superintendent of the Chicago & Alton Railroad, and it was he who executed, on behalf of the railroad company, the first contract ever made with the late George M. Pullman for Pullman sleeping cars. It was largely through Colonel Goodell's influence and sagacity that this first recognition of Mr. Pullman's sleeping cars was made which gave the "Alton" the distinction of being the pioneer sleeping car line. There were three different makes of sleeping cars originally submitted to Colonel Goodell for his choice, and after examining all patterns, the choice fell to Mr. Pullman. Colonel Goodell took Mr. Pullman to Bloomington, at which point the Chicago & Alton erecting shops then and now are located, and from two Chicago & Alton passenger coaches the first Pullmans were constructed. The first contract provided that the "C. & A." was to furnish the cars and keep up the outside, and that Mr. Pullman was to furnish and keep up the inside. While Mr. Pullman provided the drawings and patterns for his first cars, Colonel Goodell's recommendations, as the cars were under reconstruction, were exceedingly valuable to Mr. Pullman, and the friendship between the two men, formed at that time, continued until Mr. Pullman's death.

AN EXTENSIVE WATER SOFTENING INSTALLATION.

TOTAL CAPACITY, 318,000 GALLONS PER HOUR.

PITTSBURGH & LAKE ERIE RAILROAD.

II.

(Continued from page 401.)

The provision of good boiler waters is of the first importance as an operating problem. To be sure the question of economy in repairs is also important. On such a road as the Pittsburg & Lake Erie with an enormous and exacting traffic centering in such a city as Pittsburgh, the first requisite of the locomotive is that it shall be powerful and that its power shall be continuously available for service. Large capacity has been sought in some cases by merely increasing the dimensions and weights of engines, but this plan soon reaches physical limits and it does not avoid the loss of service because of boiler repairs due to bad water. When the water question is satisfactorily solved the matter of ultimate capacity may be taken up and water which is good for small boilers is also good for large ones. The plan of this road seems to be admirable because it promises to secure the utmost boiler capacity combined with continuous service of the present equipment, and furthermore, all other efforts to increase capacity are still available. Any principle tending toward obtaining the maximum possible results from present equipment appeals to us as right from a business, as well as from an engineering, standpoint and water purification seems to be the problem to which motive power and engineering talent can be most profitably applied at this time.

It is difficult to realize fully the extent to which the use of natural waters, containing scale-forming impurities, for locomotive water supply, influences the problem of caring for and maintaining locomotive boilers upon our railroads. The difficulties imposed by the formation and accumulation of scale upon the heating surfaces of boilers have, through the many years of use of steam power, come to be regarded as a necessary evil which cannot be avoided and which must be regularly provided for with care. It is the usual practice of most of our railroads to liberally provide for frequent and extensive boiler repairs and renewals, but the extra expense involved in this element of maintenance is incapable of exact determination on account of the complication and inter-connection of details—it is the experience, however, of all motive power officials that this element is very expensive and involved, and has been considered an unavoidable factor in the problem of locomotive maintenance.

The possibilities for economies that exist in the use of the water treatment system for removing the scale-forming impurities from the boiler-feed water, are thus almost beyond comprehension. Few have given this subject the consideration that it deserves and little is known, also, of the benefits to be derived. This subject was investigated with great care and analyzed most completely by the management of the Pittsburgh & Lake Erie Railroad under the direct supervision of the Engineering Department. Some of the considerations which led to the adoption of water purifying plants on a large scale on this progressive road may be of interest.

On account of the use of scale forming waters, and also of water containing free sulphuric acid, it will be admitted that bad results will inevitably come. These results may be summed up as follows:

First: Loss of fuel due to the insulating effect of scale on the flue and other heating surfaces.

Second: Loss in service of locomotives due to time required for making repairs, weekly, monthly and annually, directly chargeable to bad water conditions.

Third: Additional round house and shop expenses, due to the above work, for material and labor.

The above items will, of course, have different money values on different roads varying with the conditions; but on the Pittsburgh and Lake Erie the amounts have been estimated as stated below:

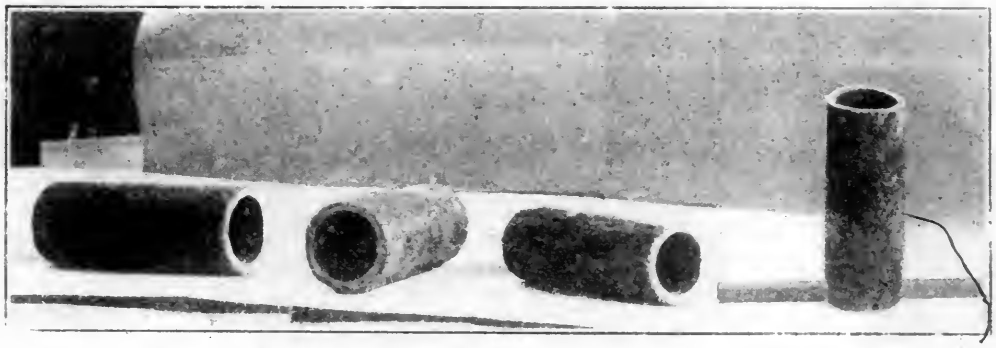
First Item: "Loss of fuel due to effect of scale, etc.":

A great deal of careful investigation has been given to the determination of the efficiency of the heating surfaces of boilers when clean and when coated with scale, and, in this connection the remarkable uniformity of the results of all such investigation is worthy of note.

In Clark's "Steam Engine," volume 1, page 218, it is stated that "a scale of a sulphate of lime 1-16 in. thick reduced the efficiency 14.7%" (as determined in a series of experiments upon a boiler). Dr. J. C. Rogers states, in the volume entitled, "Water Purification," that a scale 1-16 in. thick makes 15% more fuel necessary than with clean heating surfaces and furthermore that this ratio increases as the scale thickens. This authority also estimates the heat conductivity of boiler incrustation to bear a relation to that of wrought iron plate of 1 to 37.5. The authority, Rankine, states in his work on "Steam Engines" that the specific heat of carbonate of lime is 18 times that of iron, and that of sulphate of lime is 15 times that of iron; it is stated that the consequent waste in urging a fire for steam raising in a scaled boiler is enormous, as it is estimated that 1-16 in. of scale requires the use of 16% more fuel, while a scale $\frac{1}{4}$ in. thick will necessitate 50% more fuel, and $\frac{1}{2}$ in. of scale 150% more fuel. A noted foreign authority, Fischer's Chemisch Technologie des Wassers, page 216, states that Reuben Wells ran two engines for several months with heating surfaces covered with scale and an equal length of time later with clean heating surfaces, and found a saving of $17\frac{1}{2}$% with the clean boiler.

The remarkable uniformity of these few of the many tests that have been made in this direction tend to verify the general proposition that 1-16 in. of scale on the heating surfaces of a boiler will increase the fuel required to be burned to maintain a given temperature on the water side of the surface by approximately 14% to 17%—say 15%.

By careful investigation it has been determined that the average condition of a boiler will show at least $\frac{1}{8}$ of an inch of scale upon the heating surfaces. The nature of the scale that forms in the boilers may be judged from the accompanying photographs of sections of boiler tubes that were selected



SAMPLES OF SCALED BOILER TUBES, TAKEN FROM LOCOMOTIVES OF THE PITTSBURGH & LAKE ERIE RAILROAD, AFTER 12 MONTHS OF SERVICE WITH THE UNTREATED WATER.

as samples to show the average conditions met in practice. These tubes had been in service about a year before they were removed. The average thickness of scale on these samples is 1/8 in., although on the bottom edge it measured 3-16 in. thick. The scale is of a very hard nature, the scale forming materials evidently having strong cementing properties. The color is light brown.

This matter has been brought to the attention of several prominent motive power officials and the unanimous opinion is that 1/8 of an in. is a very conservative estimate of the average thickness of scale on different roads throughout the country. Therefore by assuming this to be true we find that on an average 30% of the fuel used has been wasted due to scale. These figures might probably be safely used, but in order that the estimate may be *under*, rather than over, actual conditions we will use only one-half this amount, or 15%, and still find the estimated loss due to this cause on the P. & L. E. R. R. amounting to about $50,000 per year—using the amount of fuel coal reported in annual report for the last fiscal year.

Second Item: "Loss in service of locomotives, etc.":

This loss has been estimated to amount to about 1-12 of the total time of the locomotive, taking into account the many times the flues and fire boxes require to have "boiler work" done on them, and also the fact that new flues have to be put in about once in every 10 months.

Putting this estimate, which is also placed on the conservative side, in plain figures, it means that on this road the company is losing constantly the use of $230,000 invested in locomotives that are unproductive on account of bad water. It would be quite reasonable to estimate this loss by using the *earning power* of the locomotive, as for a considerable time during the past two years the *locomotive capacity* measured the capacity of the road to do business; but as this would lead to *enormous* figures we will use the very conservative method by estimating simply the interest on the investment, using 5% for interest and 5% for depreciation which makes the annual loss through locomotives being out of service amount to $23,000.

Third Item: "Loss due to shop expenses on locomotives due to bad water troubles":

This item is somewhat indefinite, but taking into account labor, material and proper charge for use of shop facilities it has been estimated to amount to $100 per locomotive per year, making a total loss on this road of $20,000 per year.

Summing up these items we have an estimated loss per year of $93,000 due to bad water conditions, which is a *very* conservative estimate.

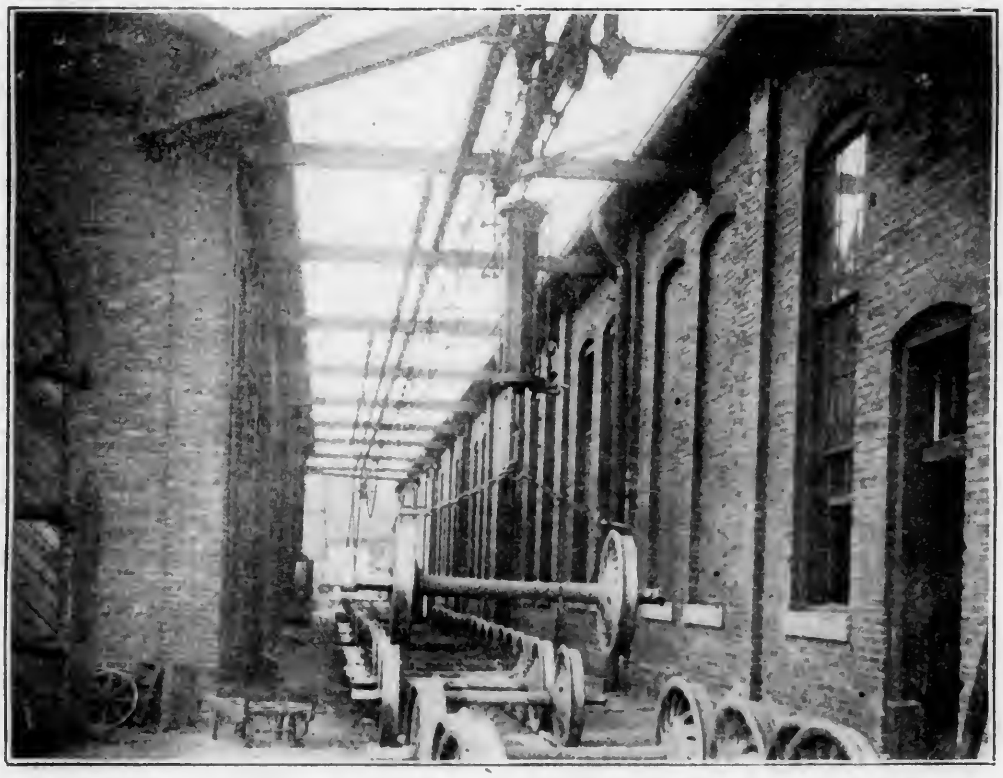
It cannot be hoped that any system of water purification now on the market will allow all of these bad conditions to be gotten away from entirely, without some expense, and probably losses in other directions; but the enormous amounts of these losses have been considered sufficient warrant for an investment in water purifying plants for the entire road.

Results are now being had which will determine whether the investment will produce the economies as described.

These results will be given in later issues.

A CAR SHOP WHEEL HOIST AND TRAVERSER.

This wheel hoist is at the Englewood car shops of the Lake Shore & Michigan Southern, and is arranged between two buildings, the one on the right being the machine shop. Wheels are run in from the yard, and as the hoist is traversed along the runway by a chain, any pair of wheels may be taken to the machine-shop door, turned and run into the building on a track. The air-cylinder is 8½ x 44 ins. controlled by handles, and the air is brought to it by a hose carried in loops by small carrier pulleys 15 ft. apart. The chain is endless, and is driven from an extended line-shaft, the clutch being operated from the machine-shop door. To traverse in one direction the cylinder carriage is clutched to the upper chain, and to drive it in the opposite direction it is connected to the lower one. This clutch is operated by cords. At first a wire cable was used for traversing, but this has been replaced by a ⅜-in. plain iron chain, which is adjusted as to length by a sheave on a swinging hanger. The device is very convenient, and saves a material amount of labor in handling wheels. It is specially valuable when a rush order of wheels must be handled in the shop when the trackway happens to be full. The device was arranged by Mr. L. G. Parish, master car-builder of the L. S. & M. S. at Englewood.



WHEEL HOIST AND TRAVERSER AT THE ENGLEWOOD SHOPS, LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

ELECTRIC TRACTION EQUIPMENT FOR THE NEW YORK CENTRAL.

The New York Central & Hudson River R. R. Co., have just placed an order with the General Electric Company for eight turbo-generators of a capacity of 7,500 h.p. each. The turbines are of the 4-stage-vertical-Curtis-type, and the generators are 25 cycle, 3-phase alternators, to generate current at a pressure of 11,000 volts. This is by far the largest order for steam turbines that has ever been placed in this country or abroad. The New York Central Company has placed with the General Electric Company, in co-operation with the Schenectady Works of the American Locomotive Company, an order for 30 electric locomotives. These locomotives are of an entirely new design. They will weigh 85 tons each, with an adhesive weight on the drivers of 67 tons. Each locomotive will have a capacity of 2,200 h.p., and will be capable of hauling a train of 500 tons at a speed of 60 miles an hour. This order has also the distinction of being by far the largest order for electric locomotives ever placed in *any* country.

COMMUNICATIONS.

TWO SPECIALLY IMPORTANT FEATURES OF BALANCED COMPOUND LOCOMOTIVES.

To the Editor:

During the past eighteen months the AMERICAN ENGINEER AND RAILROAD JOURNAL has published several valuable articles upon the Vauclain and the de Glehn systems of 4-cylinder balanced compound locomotives, but I do not recall any reference having been made to two very important advantages possessed by these engines over the ordinary 2-crank locomotive, namely: (1) The higher value of the normal coefficient of adhesion, and (2) the greater uniformity of the tractive force developed during each revolution of the driving-wheels. Since these characteristics of the balanced locomotive have, to a considerable extent, enabled it to regularly perform work in Europe for which in this country an engine of some 20 per cent. greater weight is required, I beg leave to direct special attention to them.

In any 2-crank locomotive, whether of the single-expansion, 2-cylinder compound, Vauclain, or tandem compound type, the turning moments, as is well known, vary greatly throughout the revolution, attaining their maximum theoretical value when the two cranks are in front of the axle and stand at angles of 45 degs. with horizontal or vertical lines, and decreasing from thence to the dead points, where the rotative effort falls to a minimum.

With a locomotive having four cranks set at 90 degs. to each other, the turning moments are, obviously, much more uniform than in an ordinary engine, and practically approximate very closely to the results obtained from an electric motor drive.

Now, "it is indisputable that driving-wheels with variable turning moments are much more likely to slip than those whose effort on the rails is fairly constant. A wheel begins to slip when the effort is at a maximum, which would not slip with the average effort. Once slipping begins, static friction, whose coefficient is much higher than that of dynamic friction, is lost, and the wheel once started will go on slipping. Here we have the reason why the motor bogie has apparently a higher coefficient of adhesion than has the steam locomotive." (*The Engineer*, October 30, 1903.)

To this tendency to slip caused by the variable rotative effort of the 2-crank engine must be added that due to the variation (frequently of many thousand pounds) of the effective adhesive weight during each revolution of the driving-wheels, resulting from the vertical component of the centrifugal force developed by the weights employed to partially neutralize the inertia effects of the reciprocating masses. This disturbance is, of course, entirely avoided in the balanced locomotive, and a practically constant adhesive force is thereby obtained.

The combined effect of this uniformity in the rotative effort, and in the wheel pressure of the 4-crank locomotive, is that its coefficient of adhesion is considerably greater than that of the ordinary engine. Quoting again from *The Engineer:* "The normal coefficient of adhesion in this country (England) is taken at one-sixth of the insistent weight on the drivers; we have reason to believe that with Mr. de Glehn's engine it is not less than one-fifth, or possibly more."

From this it follows that in addition to the greatly increased driving-wheel loads rendered practicable and safe by the suppression of all balancing of the reciprocating parts of the engine, the 4-crank locomotive enables a *greater proportion of the given adhesive weight to be utilized by the cylinders, and to appear as effective tractive force*, than is possible with any other type of engine.

Furthermore, the greater uniformity in the turning moments of the 4-crank than of the 2-crank locomotive, together with the elimination of the longitudinal disturbances due to the unbalanced portion of the reciprocating parts, necessarily results in a correspondingly greater uniformity in the draw-bar stress of the former than of the latter engine; the importance of which uniformity will be apparent when it is remembered that experience seems to prove beyond all dispute that a locomotive with a steady tractive effort will haul heavier and faster trains than one whose pull, although of equal mean intensity, rises and falls in amount.

From the foregoing it appears that both as regards its normal coefficient of adhesion, and its uniform tractive force, the 4-cylinder balanced compound locomotive approximates quite closely to the electric motor, and since the latter constitutes the most efficient method of railway propulsion now known, this similarity indicates that in at least two important particulars this type of engine approaches perfection.

EDWARD L. COSTER,
Assoc. Am. Soc. M. E.

25 Broad Street, New York.
November 17, 1903.

MODERN SMOKE BOX PRACTICE NOW UNDERSTOOD ABROAD.

To the Editor:

Mons. Edouard Sauvage, the prominent French motive power engineer and author of a very complete and useful treatise on the locomotive boiler, has recently published another work of interest, "Les Locomotives au Debut du XXme Siecle" (Locomotives at the beginning of the 20th Century). This book, which has not been translated and does not seem to have been reviewed by any of our technical journals, illustrates numerous examples of the most recent practice both here and in Europe, the only criticism which seems applicable to its presentation of our own being that it is deficient as to any instances of the suburban engines of the Forney type and the heavy shifting engines which have been recently introduced in the United States. The leading examples of present European practice also appear to be included, and a comparison of the book with a German publication of about the same date, "Die Lokomotiven," by von Borries and others, indicates that the latter authors have not gone any more fully into the subject of European practice.

The following translation, which the writer has made as literal as possible, of M. Sauvage's remarks on the subject of smoke boxes, on page 13 of his book, shows that European engineers are now obtaining a correct understanding of the basic and underlying fallacy of the extended smoke box system, and warrants the belief that they will follow the latest and best examples of American practice in abandoning it, without undergoing our lengthy and costly demonstration of its disadvantages.

"Smoke boxes were formerly as small as possible. Since the last ten years they have applied very much in Europe the extended smoke box, of a length of nearly 2 metres, which originated in America. By reason of its vast capacity it can collect a great quantity of cinders, drawn into it by the active draught, without causing the accumulated cinders to obstruct the discharge from the tubes. European engineers have recently learned, with a certain surprise, that a return to the box of smaller dimensions appears to be produced in America, while they extended the applications of the expanded box. Observe the motives of this new American practice. Combustion was pushed so far in the United States that the entrainments of cinders are enormous; no smoke box, whatever its capacity might be, would serve to hold all of them. Of what use then was it to keep a portion? They have then adopted the plan of so disposing the apparatus that the cinders may be thrown out of the stack, always after having been broken up by striking against the surfaces of the smoke box, in order to avoid the throwing out of large pieces which could set out fires."

It is a matter of surprise that so long a time was occupied and so much money wasted in this country, in ascertaining the fact, which ought to be an obvious one, that an extended smoke box, unless made of such "vast capacity" as to be absolutely impracticable, cannot hold any substantial fraction of the cinders that are drawn through the tubes, and that this being the case, it is practically as well to have all of them thrown out as to retain only the small portion of them which will bank up against the front of the extension. European engineers having now observed the recognition of these facts in our latest and most intelligent practice, will not be slow to recognize not only that an extended smoke box does *not* serve as a receptable to carry any material portions of the cinders (regardless of the character of the combustion in the firebox), but also that it involves the attendant disadvantages of increased cost, weight and impairment of free steaming. We are dropping the "fad" after a long and expensive experience with it, and they have the advantage that their mistake in adopting it will require infinitely less time and money for its correction.

J. SNOWDEN BELL.

Pittsburgh, November 11, 1903.

In discussing the dangerous practice of plugging staybolts in the November number of this journal, it was stated that "the well known hollow staybolts cannot be plugged from the outside without putting the fire out." This needs a little explanation, because it was not understood by at least one of our readers. The intention of the writer of that statement was to say that a hollow staybolt cannot be plugged from the outside without sending steam through the broken bolt to the inside of the firebox. This journal is edited for the high-class motive power official, and it is inconceivable that anyone who cares to read it would be guilty of such a criminal act as to plug a staybolt under any circumstances. We wished to point out, however, the difficulty of performing such an abominable trick in the case of a hollow staybolt.

as samples to show the average conditions met in practice. These tubes had been in service about a year before they were removed. The average thickness of scale on these samples is [illegible], although on the bottom edge it measured 3-16 in. thick. The scale is of a very hard nature, the scale forming materials evidently having strong cementing properties. The color is [illegible].

This matter has been brought to the attention of several prominent [illegible] and the unanimous opinion is that [illegible] of an inch is a very conservative estimate of the average thickness [illegible] different roads throughout the country. Therefore, by assuming this to be true we find that on an average [illegible] of the fuel used has been wasted due to scale. These figures might probably be safely used, but in order that the estimate may be under rather than over actual conditions we will [illegible] one-half this amount, or 15 [illegible], and still find the estimated loss due to this cause on the P. & L. E. R. R. amounts to [illegible] per year, using the amount of fuel coal [illegible] the annual report for the last fiscal year.

Second Item: "[illegible] service of locomotives, etc."

This loss has been estimated to amount to about 1-12 of the total time of the locomotives, taking into account the many times the [illegible] fire boxes require to have "boiler work" done on them and also the fact that new flues have to be put in about [illegible] 10 months.

Putting this estimate, which is also placed on the conservative side, [illegible] it means that on this road the company is being deprived of the use of $250,000 invested in locomotives that are unproductive on account of bad water. It would be quite reasonable to estimate this loss by using the *earning power* of the locomotive, as for a considerable time during the past two years the *locomotive capacity* measured the capacity of the road to do business; but as this would lead to *enormous* figures we will use the very conservative method by estimating simply the interest on the investment, using 5% for interest and 5% for depreciation which makes the annual loss through locomotives being out of service amount to $25,000.

Third Item: "Loss due to shop expenses on locomotives due to bad water troubles":

This item is somewhat indefinite, but taking into account labor, material and proper charge for use of shop facilities it has been estimated to amount to $100 per locomotive per year, making a total loss on this road of $20,000 per year.

Summing up these items we have an estimated loss per year of $[illegible] due to bad water conditions, which is a *very* conservative estimate.

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In any 2-crank locomotive, whether of the single-expansion, 2-cylinder compound, Vauclain, or tandem compound type, the turning moments, as is well known, vary greatly throughout the revolution, attaining their maximum theoretical value when the two cranks are in front of the axle and stand at angles of 45 degs. with horizontal or vertical lines, and decreasing from thence to the dead points, where the rotative effort falls to a minimum.

With a locomotive having four cranks set at 90 degs. to each other, the turning moments are, obviously, much more uniform than in an ordinary engine, and practically approximate very closely to the results obtained from an electric motor drive.

Now, "it is indisputable that driving-wheels with variable turning moments are much more likely to slip than those whose effort on the rails is fairly constant. A wheel begins to slip when the effort is at a maximum, which would not slip with the average effort. Once slipping begins, static friction, whose coefficient is much higher than that of dynamic friction, is lost, and the wheel once started will go on slipping. Here we have the reason why the motor bogie has apparently a higher coefficient of adhesion than has the steam locomotive." (*The Engineer*, October 30, 1903.)

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From this it follows that in addition to the greatly increased driving-wheel loads rendered practicable and safe by the suppression of all balancing of the reciprocating parts of the engine, the 4-crank locomotive enables a *greater proportion of the given adhesive weight to be utilized by the cylinders, and to appear as effective tractive force*, than is possible with any other type of engine.

Furthermore, the greater uniformity in the turning moments of the 4-crank than of the 2-crank locomotive, together with the elimination of the longitudinal disturbances due to the unbalanced portion of the reciprocating parts, necessarily results in a correspondingly greater uniformity in the draw-bar stress of the former than of the latter engine; the importance of which uniformity will be apparent when it is remembered that experience seems to prove beyond all dispute that a locomotive with a steady tractive effort will haul heavier and faster trains than one whose pull, although of equal mean intensity, rises and falls in amount.

From the foregoing it appears that both as regards its normal coefficient of adhesion, and its uniform tractive force, the 4-cylinder balanced compound locomotive approximates quite closely to the electric motor, and since the latter constitutes the most efficient method of railway propulsion now known, this similarity indicates that in at least two important particulars this type of engine approaches perfection.

EDWARD L. COSTER,
Assoc. Am. Soc. M. E.

25 Broad Street, New York.
November 17, 1903.

MODERN SMOKE BOX PRACTICE NOW UNDERSTOOD ABROAD.

To the Editor:

Mons. Edouard Sauvage, the prominent French [illegible] power engineer and author of a very complete and [illegible] treatise on the locomotive boiler, has recently [illegible] another work of interest, "Les Locomotives au Début du XX[illegible]cle" (Locomotives at the beginning of the 20th Century) [illegible] book, which has not been [illegible] and does not [illegible] viewed by [illegible] journals, [illegible] ples of [illegible] criticism which [illegible] being that it is [illegible] any instances of [illegible] of the Forney type and the heavy shifting engines which [illegible] recently introduced in the United States. The [illegible] of present European practice also appear to be [illegible] comparison of the book with a German publication [illegible] same date, "Die Lokomotiven," by von Borries and [illegible] than the [illegible] have not gone any more fully [illegible] ject of European [illegible].

The following translation, which the writer [illegible] as possible, of M. Sauvage's remarks on the [illegible] on page 1[illegible] of the book, shows that European [illegible] obtaining a [illegible] understanding of the [illegible] fallacy of the [illegible] smoke box [illegible] that they will [illegible] practice [illegible] costly [illegible]:

"Smoke boxes [illegible] small [illegible] ten years [illegible] smoke box [illegible] nearly 2 [illegible] America. By [illegible] quantity of [illegible] by the [illegible] draught [illegible] causing the [illegible] to obstruct the [illegible] tubes. European [illegible] have recently learned, with [illegible] surprise, that [illegible] box of smaller dimensions [illegible] be produced in America [illegible] they extended the applications of the expanded box. [illegible] of this new American practice. Combustion [illegible] far in the United States that the entrainments of cinders are enormous; no smoke box, whatever its capacity might be, would serve to hold all of them. Of what use then was it to keep [illegible]? They have then adopted the plan of so disposing [illegible] that the cinders may be thrown out of the stack, always after having been broken up by striking against the surfaces of the smoke box, in order to avoid the throwing out of large pieces which could set out fires."

It is a matter of surprise that so long a time was occupied and so much money wasted in this country, in ascertaining the fact, which ought to be an [illegible] one, that an extended smoke box, unless made of such "vast capacity" as to be absolutely [illegible], cannot hold any substantial fraction of the cinders that are drawn through the tubes, and that this being the case, it is [illegible] as well to have all of them thrown out as to retain only the small portion of them which bank up against the front of the extension. European engineers having now observed the [illegible] of these facts in our [illegible] and most intelligent practice, will not be slow to recognize [illegible] that an extended smoke box does not serve as a receptacle to carry any material portions of the cinders (regardless of the character of the combustion in the firebox), but also that it involves the attendant disadvantages of increased cost, weight and impairment of free steaming. We are dropping the "fad" after a long and extensive experience with it, and they have the advantage that their mistake in adopting it will require infinitely less time and money for its correction.

J. SNOWDEN BELL.

Pittsburgh, November 11, 1903.

In discussing the dangerous practice of plugging staybolts in the November number of this journal, it was stated that "the well known hollow staybolts cannot be plugged from the outside without putting the fire out." This needs a little explanation, because it was not understood by at least one of our readers. The intention of the writer of that statement was to say that a hollow staybolt cannot be plugged from the outside without sending steam through the broken bolt to the inside of the firebox. This journal is edited for the high-class motive power official, and it is inconceivable that anyone who cares to read it would be guilty of such a criminal act as to plug a staybolt under any circumstances. We wished to point out, however, the difficulty of performing such an abominable trick in the case of a hollow staybolt.

(Established 1832.)

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

247 new subscriptions received in this office during the month of November.

CONTENTS.

Mr. G. M. Basford, editor of this journal, sailed Nov. 21st, for the trip to Europe, as noted in our editorial columns of the preceding issue. He will remain abroad about ten weeks.

The president of a well-known railroad makes a practice of using the technical journals in a way which might well be followed by others. He is a systematic reader of the papers and makes a practice of marking articles referring to the operation of the various departments and calling the attention of the heads of the departments to such as he finds specially interesting or suggestive. If done in a broad-minded way this is an excellent plan, and one from which important results may be obtained. The president, however, is not the only officer who may use this method effectively. A Western master mechanic does practically the same thing among his foremen and shop men. He marks articles and sends them with a letter to certain men, asking for a written opinion upon the applicability of the suggestion contained in the article to the local conditions. In this case it is not the opinion that is desired so much as the assurance that the papers are read and the suggestions noticed. This officer finds this plan so satisfactory that he is to extend it and bring the technical papers into the discussions at the meetings of the foremen and shop men, which he holds at regular intervals.

Those who are responsible for the design of locomotives for present day conditions of service should bear in mind the fact that they are not building for to-day alone, but for the next twenty years. For this reason it is important to provide sufficient capacity to guard against the possibility of finding it necessary to ultimately convert locomotives to another type or discard them altogether, because they are inadequate for economical performance. A freight locomotive with 17-in. cylinders, carrying 140 lbs. steam pressure is almost entirely useless to-day if it be of a type which does not readily lend itself to conversion into a switch engine; yet many such locomotives are still in service. To many general managers a locomotive is a locomotive, and it is not always easy to secure approval of the "scrapping" of old engines, although such a course is obviously correct from a business standpoint. It is possible to build locomotives to designs which will insure economical service to the end, but this requires a long look into the future. The present experience of a number of roads indicates the importance of using the greatest possible skill in original designs in order to keep locomotive equipment up to advancing requirements. To properly design locomotives to-day requires a high grade of ability, experience and knowledge of operating conditions. In this function motive power superintendents are called upon to exercise a degree of skill and ability which was formerly not needed. With the tendency of the time toward concentration of ownership it may be said that too much care cannot be taken in the development of every new design which is to remain for years as an indication of the character of business ability of those in responsible charge. In this matter a lesson lies not deeply hidden, to the effect that it would be well to magnify the importance of the officers who are directly in charge of this important work.

PROMOTION FROM THE RANKS.

Most people are not satisfied with their situation in life, and if it were not so there would be little or no progress or improvement in any direction. Dissatisfaction with what we are and what we have is the incentive to do better things. Therefore dissatisfaction in this sense is a good thing. If a man is satisfied to perform the same service for twenty years, in the same way and with no improvement in position or compensation he is not fit even for that position and must eventually move backward. Those who are responsible for the work of many men may take this dissatisfaction for granted and neglect it. They are the men who are unable to retain the service of good men. They deserve to lose every good man.

On the other hand they may take advantage of it to promote and encourage every man who is dissatisfied enough to improve his work and prepare for greater responsibilities.

Herein is the success of men like Carnegie, and herein lies the failure of many large concerns to secure and keep the right sort of men. Railroads can be mentioned on which this principle has not taken a strong growth. In such cases important positions are always filled with "new blood." The old blood understands this policy to mean that hope of advancement and promotion is cut off from all who cannot bring strong influence to bear upon their own interests, and few are able to do this.

This situation is not only unbusiness-like, but it is positively dangerous to the advancement of those who are responsible for it. How can an organization of discouraged subordinates accomplish good work? It is impossible to do "good railroading" under any such conditions. Those who are making the fatal mistake of neglecting the principle of promotion from the ranks should give this matter a thought and rectify it before it is too late.

VARIABLE-SPEED DRIVES AND FEEDS.

The opinion is held by some that the introduction of the positive-drive speed-changing mechanism for the feeds and drives of machine tools, which is being resorted to by progressive tool builders, is being overdone—that too many speeds are usually provided for, etc. In one instance a contemporary states editorially, that "a reversion is noted in some orders recently placed in that the specifications call for but two or three possible changes of speed."

We believe, however, that the variable speed mechanism has not been introduced nearly to the extent that its advantages justify and, further, that the advantages of its use are far from being sufficiently appreciated; this belief is fully sustained by the fact that all of our more progressive tool builders, in this country, are using and perfecting such devices wherever it is possible to use them, and again by the fact that the English and other foreign tool builders have been doing so for some time. The fact, that "in some orders recently placed" only two or three speed changes are called for, does not indicate a "reversion" from the use of this improvement, but rather a further step in progress, in that the tools are to be specialized for the work in which they are to be used. This is as commendable as is the use of the speed changing mechanism.

Where tools are to be used for varying classes of work, such as is the case with drilling machines and lathes (unless specialized) the provision of speed changes in the drives, either by variable speed motors, or mechanically, is absolutely essential for progressive and time-saving machining operations, and any statement to the effect that "the best way to insure the best cutting speed to be maintained would appear to lie in taking from the workman the ability to vary such speed," is absolutely wrong.

PERSONALS.

Mr. John Cullinan has resigned as master mechanic of the Pennsylvania lines at Toledo, Ohio.

Mr. W. E. Anderson, master mechanic of the Chicago, Rock Island & Pacific at Goodland, Kansas, has resigned.

Mr. R. M. Crown has been appointed superintendent of motive power of the Warren & Corsicana Pacific, with office at Warren, Texas.

Mr. P. H. McGuire has been appointed master mechanic of the Great Northern, with headquarters at Superior, Wis., succeeding Mr. G. A. Bruce.

Mr. A. L. Robinson has been appointed master mechanic of the St. Louis-Louisville lines of the Southern Ry., with headquarters at Princeton, Ind.

Mr. R. S. Wickersham has resigned as assistant engineer of tests of the Sante Fe, to enter the service of the Chicago & Northwestern as roundhouse foreman at Hawarden, Iowa.

Mr. T. M. Ramsdell has resigned as chief car inspector of the Sante Fe to accept the position of master car builder of the Chesapeake & Ohio, with headquarters at Huntington, W. Va.

Mr. C. Kyle, formerly master mechanic of the Algoma Central & Hudson Bay, is now master mechanic of the Lake Superior division of the Canadian Pacific, with headquarters at North Bay, Ont.

Mr. F. C. Cleaver has been appointed superintendent of motive power and rolling stock of the Rutland Railroad, to succeed Mr. P. T. Lonergan, resigned. His headquarters are at Rutland, Vt.

Mr. W. D. Watkins has been promoted from the position of traveling engineer on the Illinois Central to that of master mechanic, with headquarters at Water Valley, Miss., succeeding Mr. J. F. Price, resigned.

Mr. Charles H. Hines has been appointed electrical engineer of the Canadian Pacific Railway, with office in Montreal. He has general charge of the electrical works, such as lighting and power, for the entire road.

Mr. Charles A. Goodnow, who recently resigned as general manager of the Chicago, Rock Island & Pacific, has been appointed general manager of the Chicago & Alton. Mr. James H. Barrett, general superintendent of the latter company, has resigned.

Mr. Philip Reeves, heretofore general foreman of the Baltimore & Ohio Southwestern, at Chillicothe, O., has been appointed master mechanic at that point to succeed Mr. F. J. Smith, who has been transferred to Washington, Ind., in the same capacity.

Mr. J. G. Neuffer has accepted the position of assistant superintendent of machinery of the Illinois Central Railroad, with office in Chicago. He has resigned as superintendent of motive power of the Baltimore & Ohio Southwestern after having been connected with that road for 30 years.

Mr. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie was chosen as president of the Railway Club of Pittsburgh, at its recent meeting, and Mr. F. T. Hyndman, master mechanic of the Buffalo, Rochester & Pittsburgh at Du Bois, Pa., was elected vice-president. Mr. J. D. McIlwain was re-elected as treasurer.

Mr. Elliot Sumner has been appointed assistant engineer of motive power of the Pennsylvania R. R., at Altoona, Pa., succeeding to the position recently made vacant by the transfer of Mr. I. B. Thomas to Pittsburgh, Pa., as master mechanic. Mr. Sumner heretofore has held the position as assistant engineer of motive power at Buffalo, N. Y.

Mr. John Hair has been promoted from the position of master mechanic of the Baltimore & Ohio Southwestern at Washington, Ind., to succeed Mr. J. G. Neuffer as superintendent of motive power, with headquarters at Cincinnati, Ohio. Mr. Hair is succeeded at Washington, Ind., by Mr. F. J. Smith, master mechanic at Chillicothe, Ohio, and Mr. Smith is succeeded at that point by Mr. Philip Reeves, general foreman.

Mr. Clarence P. Day has accepted the position of manager of the eastern business interests of *The Railway and Engineering Review* of Chicago, with headquarters at 140 Nassau street, New York. His many friends will be pleased to know that he has returned to this field in which he has spent so many years and in which he has been so successful. Mr. Day will have charge of all of the territory east of Pittsburgh.

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.

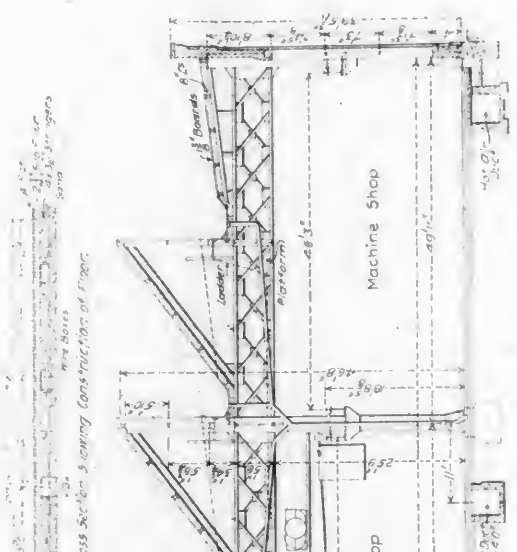
PITTSBURGH & LAKE ERIE RAILROAD.

II.

ERECTING AND MACHINE SHOP.

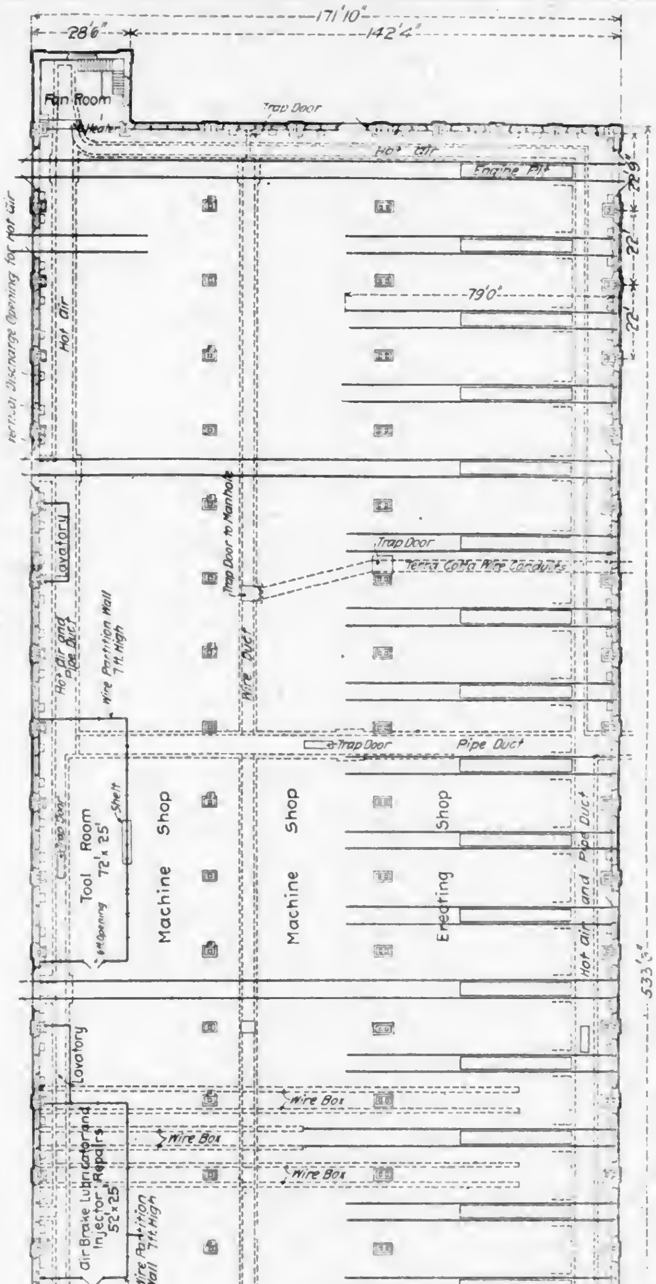
In this article the details of building construction for the combined locomotive and erecting shop building will be presented. An excellent idea may be gained of the proportions of this building by reference to the exterior and interior views, which are reproduced in the accompanying engravings. The exterior view, the photo for which was taken from the bluff at the rear of the shops, well illustrates the attractive architectural result from the brickwork enclosure of the steel work and from the carefully designed cornice, as well as also the excellent provision for daylight lighting. The entire building, both erecting and machine shop portions, present a most symmetrical and pleasing appearance.

The building is of the modern steel-skeleton construction.



CROSS SECTION OF THE COMBINED ERECTING AND MACHINE SHOP, SHOWING ARRANGEMENT OF CRANES AND DETAILS OF ROOF CONSTRUCTION.

(Longitudinal Section of Floor, Showing Construction and Scheme of Wire Boxes, in Detail Sketch Above.)



PLAN OF THE MACHINE AND ERECTING SHOP BUILDING, SHOWING TRANSVERSE ARRANGEMENT OF PITS IN ERECTING SHOP. ALSO DETAIL OF WIRE SCREEN PARTITION FOR TOOL ROOM, ETC.

NEW LOCOMOTIVE SHOPS AT McKEES ROCKS.—PITTSBURGH & LAKE ERIE RAILROAD.

with 18 in. walls and brickwork pilasters between the windows, enclosing the frame columns of the building. The brickwork of the building is tied to the steel, but is otherwise entirely independent. The foundations are of concrete throughout.

The building is of great length, 533 ft. long, and is divided into three bays by the longitudinal rows of columns, as shown in the plan view. The erecting shop, which occupies the bay at the south side of the building, is 68 ft. 9 in. wide; the machine shop occupies the two other bays on the north side, one 49 ft. 5 in., and other 49 ft. 11 in. The steel columns are symmetrically placed throughout the building, the spacing being in all cases 22 ft. between centers, except at the extreme east and west ends of the building, where it is 22 ft. 9 in. The distances between erecting shop pit centers is 22 ft. in each case. The steel work for this building was designed by Mr. Albert Lucius, of New York, and was erected by the McClintock-Marshall Construction Company, Pittsburgh, Pa.

THE STEEL WORK.

The substantial character of the steel work in the framing may be judged from the interior views as well as from the cross-section. The general plan of the steel work and its longitudinal bracing is similar to that made use of in the locomotive shop building at the Collinwood shops of the Lake Shore & Michigan Southern, (see page 366, December, 1902). Longitudinal bracing is provided between columns in alternate bays, with expansion bays between, like a trestle.

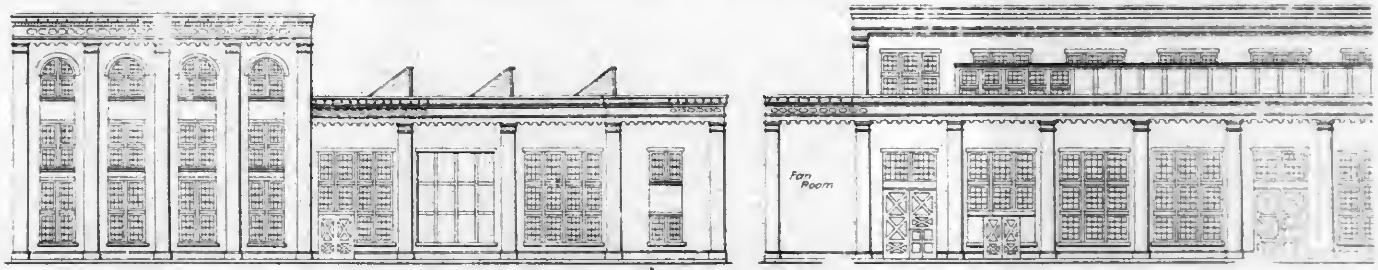
Construction was greatly simplified by using columns exactly alike in the longitudinal rows. The columns were in all cases designed to support not only the brickwork and roof, but also the crane runways and without extra complication to provide for the latter. The columns, in this building, however, are in no case filled with concrete inside.

Extra heavy steel was provided for the cranes. The runways for the 120-ton crane in the erecting shop are 5 ft. plate girders, and are located 65 ft. between centers; those for the 10-ton crane are 2½ ft. plate girders, with a 62 ft. span between centers. The runways for the 7½-ton crane in the heavy tool section of the machine shop are 2 ft. plate girders, located with a crane span of 46 ft. 3 in. between centers. For the 120-ton crane a rail weighing 100 lbs. to the yard was used, while for the smaller cranes a 60-lb. rail was used. Particularly heavy construction was used to amply provide for the heavy rolling loads to be imposed by the cranes.

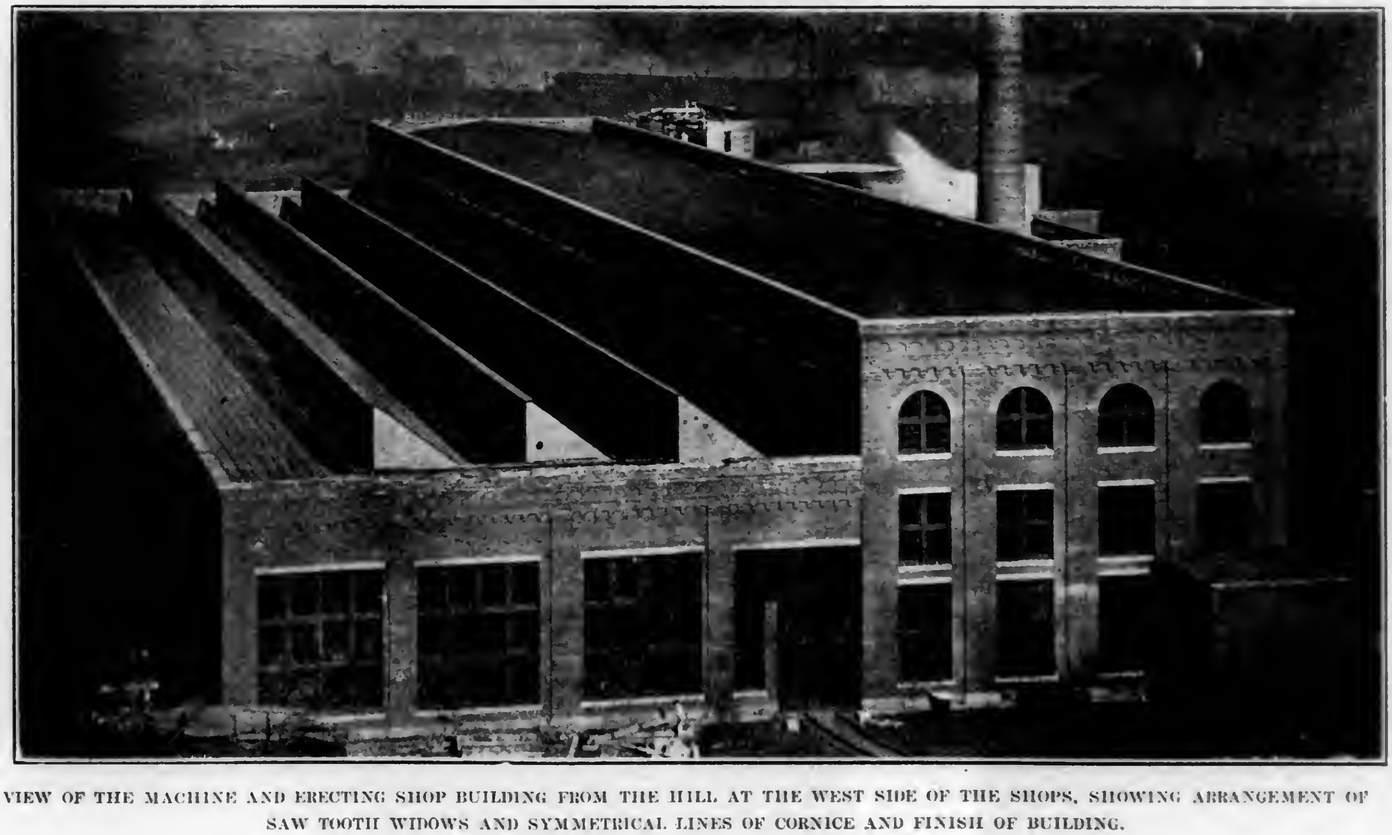
THE FLOOR.

The details of the method of floor construction used are well illustrated in the sectional detail included in the cross-section view. The entire floor of the building has a base of concrete, 4 in. thick. This is covered with five layers of felt, which are laid saturated with asphalt, for waterproofing. The floor stringers are laid above this, bedded in well dried sand, to carry the sub-floor; the sub-floor is of 2¾ in. yellow pine, while the top floor is 1⅛ in. tongued and grooved maple. The concrete used in this floor is composed of American Portland cement, sand and stone in the proportions of one, five and eight.

This construction is one of the most important features of the entire shop, as it has produced a floor capable of carrying machine loads limited only by the crushing strength of the maple of the top floor. As a result most of the machines, that do not require space below the floor surface, are placed on



ELEVATION OF EAST END, AND PARTIAL ELEVATION OF NORTH SIDE, OF THE MACHINE AND ERECTING SHOP BUILDING.



VIEW OF THE MACHINE AND ERECTING SHOP BUILDING FROM THE HILL AT THE WEST SIDE OF THE SHOPS, SHOWING ARRANGEMENT OF SAW TOOTH WIDOWS AND SYMMETRICAL LINES OF CORNICE AND FINISH OF BUILDING.

McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

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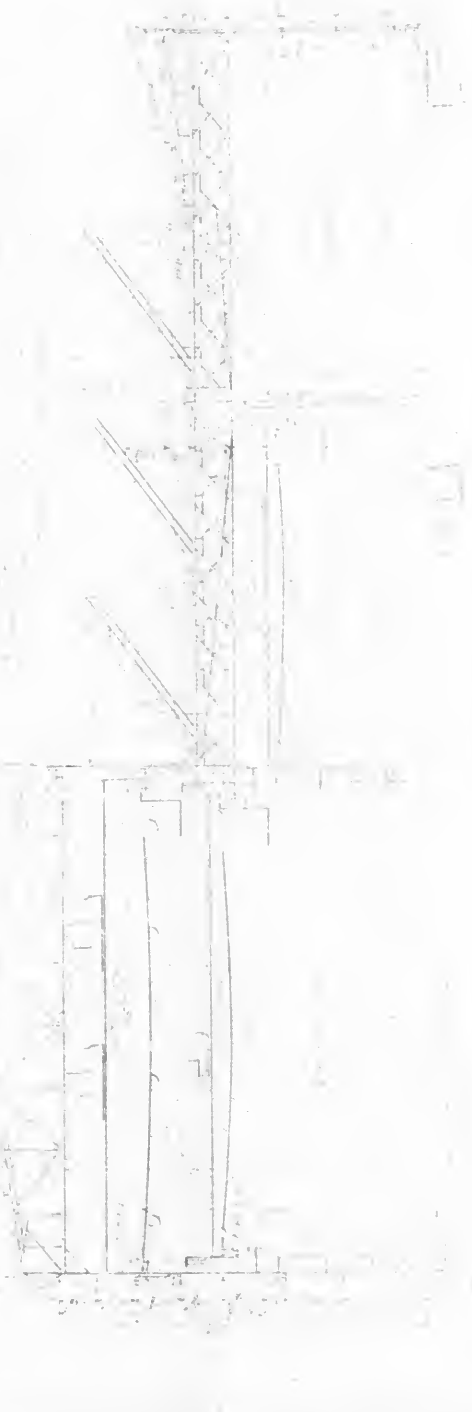
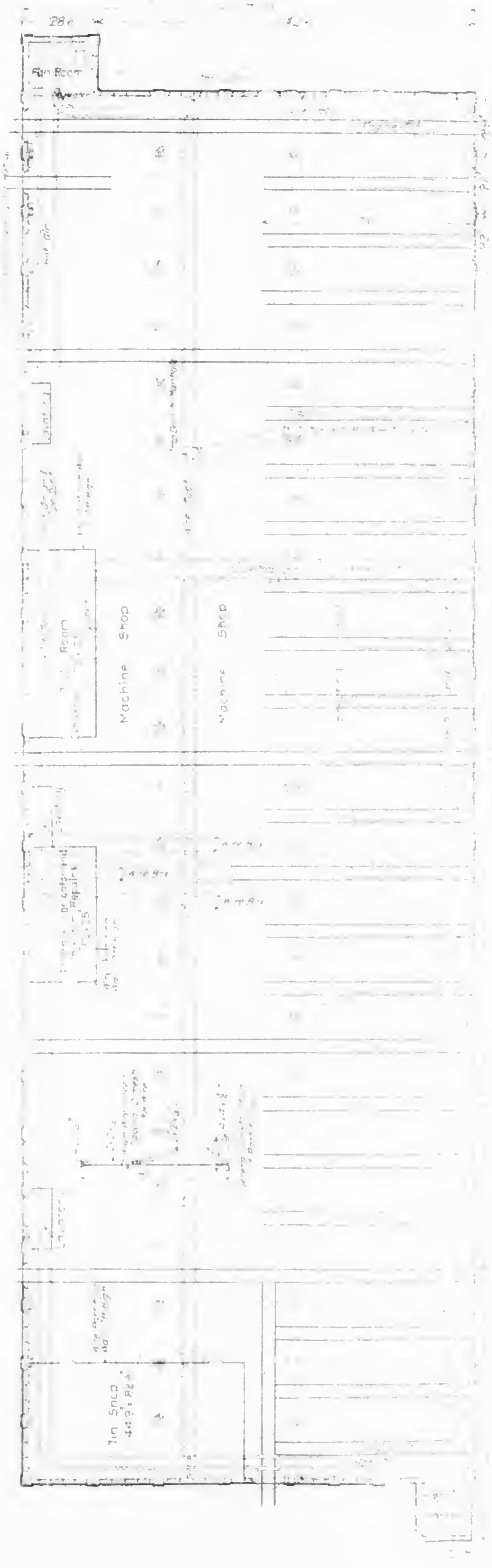


CROSS SECTION OF THE COMBINED ERECTING AND MACHINE SHOP [illegible]

Longitudinal Section of Eaves, Showing Coping [illegible] in Detail Sketch Above.



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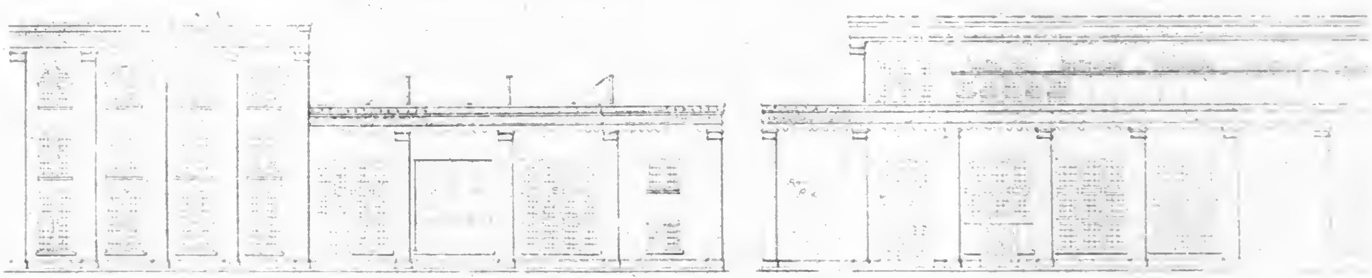

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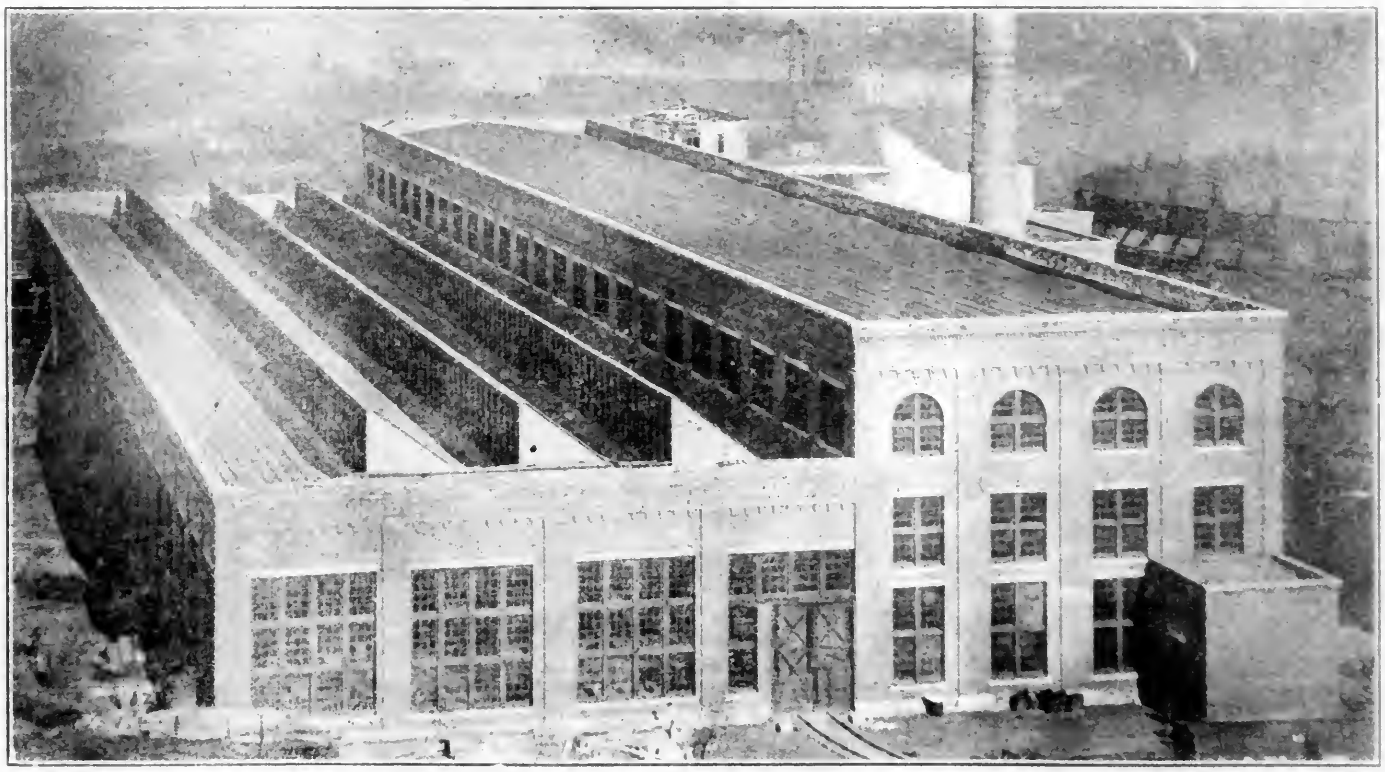

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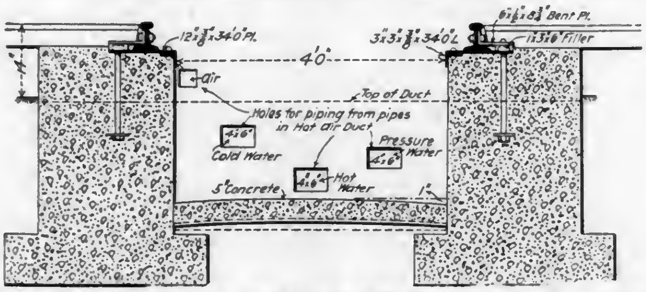
McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

INTERIOR VIEW IN ERECTING SHOP, SHOWING 120-TON CRANE LIFTING A BOILER. SHOWING ALSO HEAVY CHARACTER OF STEEL CONSTRUCTION.

and attached to the floor without special foundations—thus making it practicable for the arrangement of the machines to be changed at will.

Another important feature of this floor construction is the



CROSS-SECTION SHOWING DETAILS OF ERECTING PIT CONSTRUCTION.

provision of wire boxes, as indicated in the sectional detail. In every third space between the stringers, which run crosswise of the building, the sand filling is withheld and kept out by stops of ⅞ in. board, which are merely nailed against the stringer on each side of the space as shown, and extend from the felt up to the sub-floor. This forms an open channel, or duct, which runs entirely across the building and provides a most excellent method for running power and light wires, in pipe conduits from the main wire tunnel or trench running longitudinally through the shop, to the various tools upon which electric motors are used. The arrangement of these wire boxes in the vicinity of the pits is shown in the plan drawing; there are four to each bay and they extend from the north wall across the wire trench to a point opposite the middle of the erecting pits, or up to the erecting pit tracks where they are in the way. The use of these wire boxes will be referred to in another article.

THE ROOF.

The details of the roof steel work are well shown in the cross-section view and also in the detail drawing of the saw-tooth construction, which is used above the machine shop section of the building. In the erecting shop small columns are carried up from the crane columns, ending in large gusset plates, which support the roof trusses and also serve to provide cross bracing. The details of the saw-tooth construction are made clear in the engraving, which shows a cross-section through the saw-tooth windows at the quarter points of the machine shop roof.

The roof consists of a base of 1⅜-inch tongued and grooved boards, upon both erecting and machine shop sections, and upon this is laid the roofing felt. The felt is laid heavily saturated in asphalt. Considerable anxiety was experienced in regard to obtaining a suitable roofing material for covering the saw-tooth section of the roof—particularly the trench portion, as it had been thought desirable to make it waterproof for at least one foot above the bottom to take care of snow and water. As one side of this trench is vertical, the conditions will be appreciated as being unusually severe for asphalt roof construction. The roofing material has, however, been put in place, meeting the above conditions, by the Eastern Granite Roofing Company of New York, under an absolute guarantee for ten years.

Inside drainage is made use of throughout, to eliminate the possibility of backing up of water due to conductor pipes freezing. The conductor pipes, which are 5 inches in diameter, for the erecting shop section, lead from the flashing boxes to the longitudinal discharge pipes, of which there is one, 8 inches in diameter, carried along under each side of the roof, and supported by the roof steel work, as shown in the cross-section. For the machine shop, 4-inch conductors lead from the flashing boxes to a 5-inch vertical discharge pipe, one of which is arranged alongside of every other column of the middle row, extending through the shop. There are 12 "low," or drainage spots in the roof construction, which amply provide for the drainage.

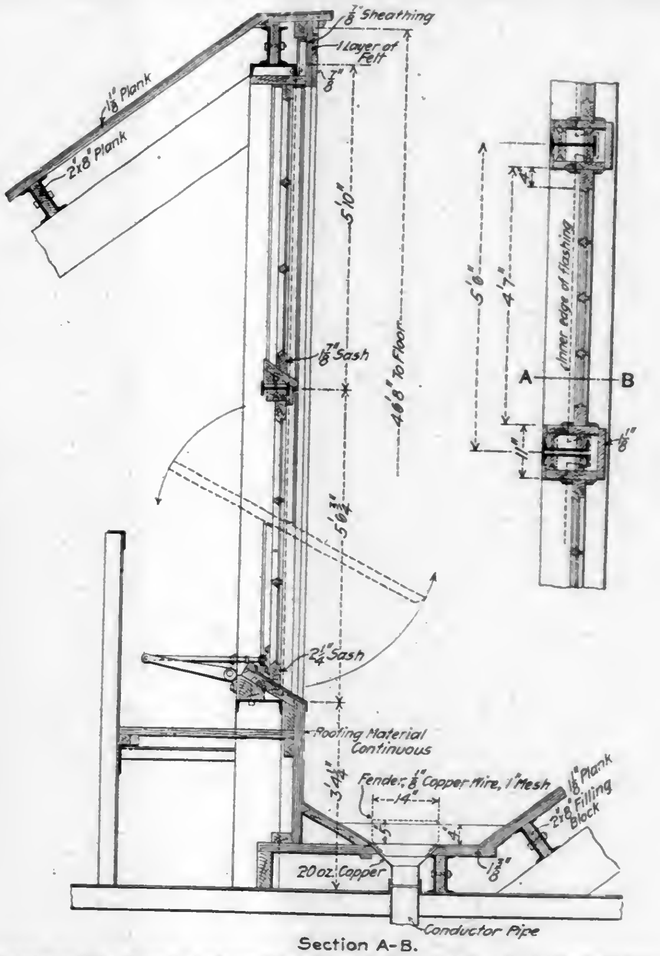
No direct ventilation is provided in the erecting portion, but the machine shop has excellent provision for ventilation in the saw-tooth windows. These are arranged to be operated in sections, of which there are eight to each saw-tooth, from the

floor of the shop by hand wheels, the mechanism for which is indicated in the saw-tooth sectional detail. Special provision is made for ventilating the water closets, which are located within the shop building, but the details of the latter will appear later in connection with the lavatories and heating system.

GENERAL.

The constructional details of the erecting pits are indicated in a cross-sectional detail drawing. The side walls are of massive concrete construction and are surmounted by a 3/8 by 12 in. plate, 34 ft. long, on each side to provide bearing for the rails. A 3 by 3 by 3/8 in. angle, riveted to the outer edge, protects the outer corner of each concrete side wall, as shown. The plate is anchored to the walls by 3/4 by 16 in. anchor bolts, which are spaced 6 ft. 4 in. apart, and the rails

VIEW OF THE MACHINE SHOP ROOF, SHOWING SAW-TOOTH WINDOWS.



Section A-B.

HORIZONTAL SECTION THROUGH SAW-TOOTH WINDOWS, AND VERTICAL SECTION, A-B, SHOWING SAW-TOOTH CONSTRUCTION.

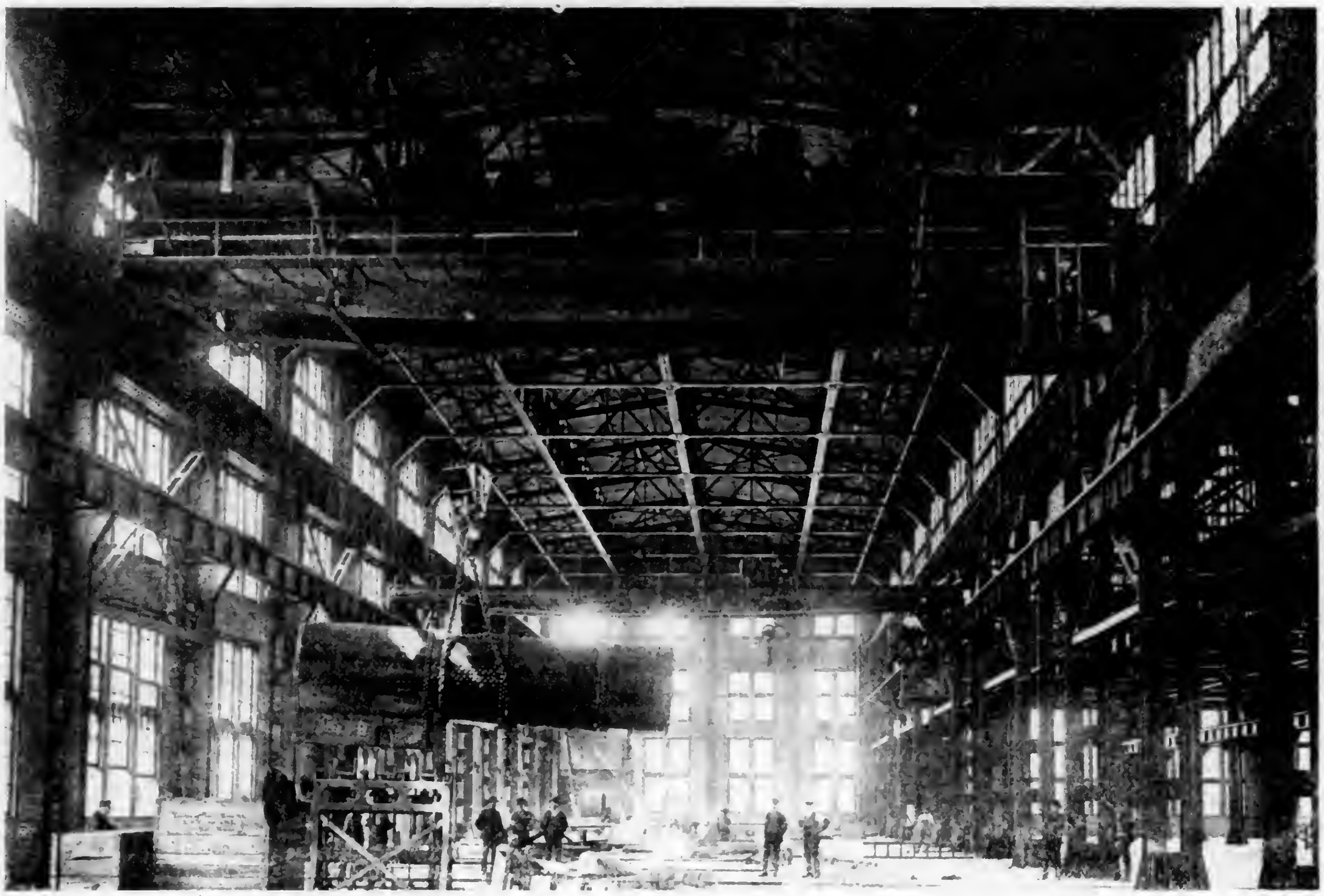
INTERIOR VIEW OF THE MACHINE SHOP, SHOWING DAYLIGHT LIGHTING EFFECT FROM THE SAW-TOOTH WINDOWS.

McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

are tied to this plate by special angle fittings, riveted to the plate and raised, so as to easily bolt to the rail.

Each pit is furnished with connections for compressed air, cold water at 80 lbs. and, by a simple patented device, with water at about 200 degrees F. temperature, under a pressure of 100 lbs. per square inch, which latter connection is manifolded with a hydraulic pressure line. The manifold connection makes it possible to fill boilers on the erecting pits with hot water and then test them to any desired pressure up to 300 lbs. per sq. in., and this is accomplished by the use of only one connection with the boiler.

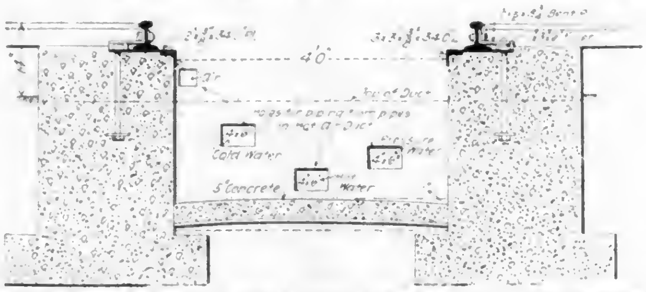
An interesting detail of the shop construction is to be seen



INTERIOR VIEW IN ERECTING SHOP, SHOWING 120-TON CRANE LIFTING A BOILER. SHOWING ALSO HEAVY CHARACTER OF STEEL CONSTRUCTION.

and attached to the floor without special foundations—thus making it practicable for the arrangement of the machines to be changed at will.

Another important feature of this floor construction is the



CROSS-SECTION SHOWING DETAILS OF ERECTING PIT CONSTRUCTION.

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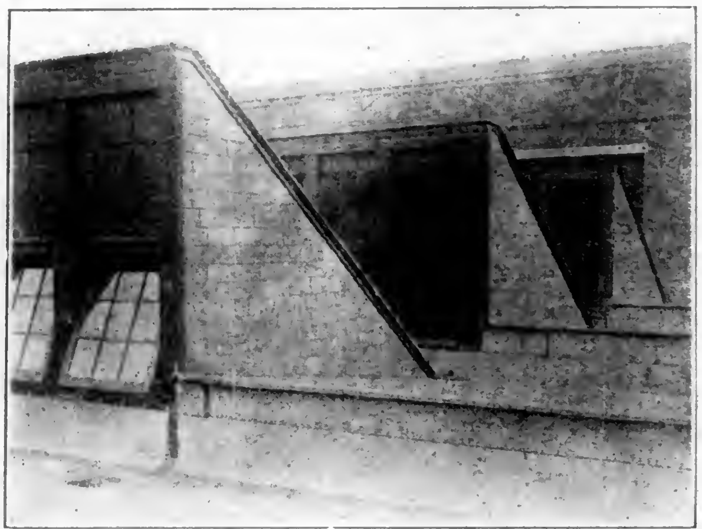
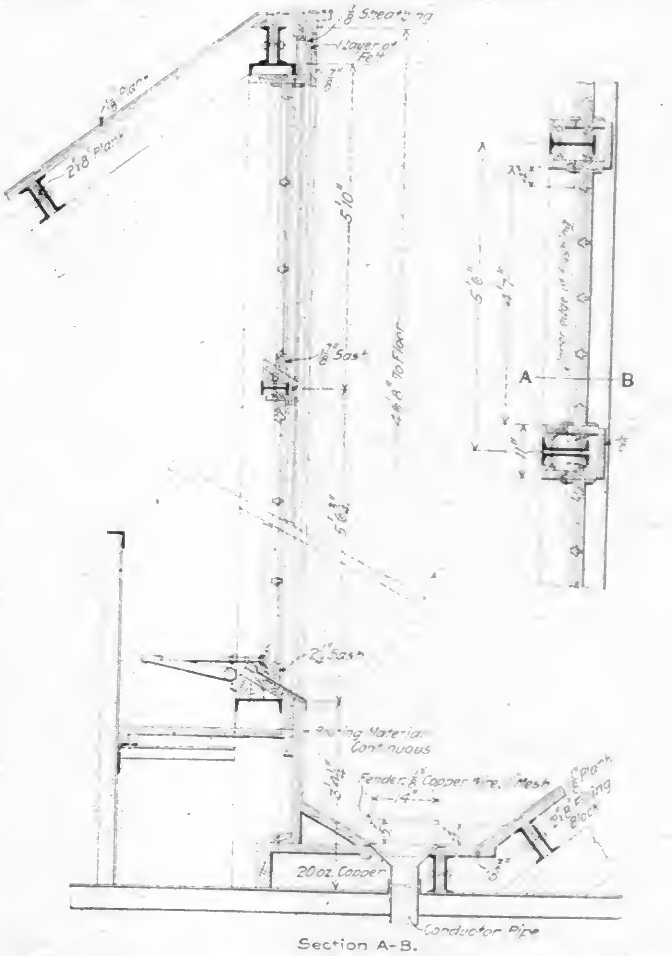


VIEW OF THE MACHINE SHOP ROOF, SHOWING SAW-TOOTH WINDOWS.



Section A-B.

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INTERIOR VIEW OF THE MACHINE SHOP, SHOWING DAYLIGHT LIGHTING EFFECT FROM THE SAW-TOOTH WINDOWS

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An interesting detail of the shop construction is to be seen

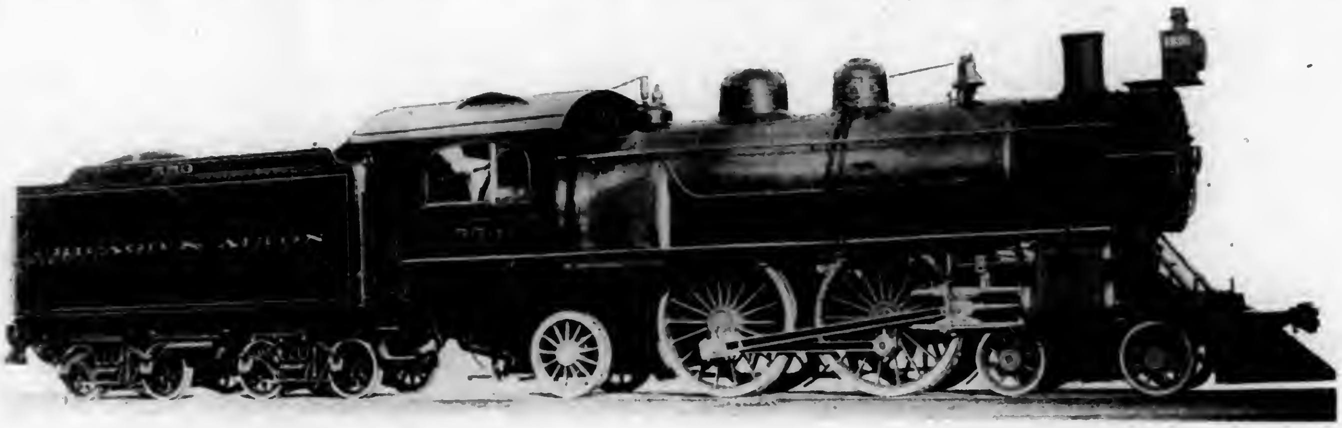
in the details of the partitions used for enclosing the tool room, and the tin shop and air brake repair departments in the machine shop (see the plan drawing). The partitions used consist of woven-wire screen, supported upon angle-iron posts and frame work, the details of which are indicated in the small detail sketch inserted on the plan drawing. The doors leading through these partitions are also of similar construction, making the entire partition work absolutely fireproof, as well as of the most approved sanitary construction.

NEW PASSENGER LOCOMOTIVES.

4-4-2 (ATLANTIC) TYPE.

CHICAGO & ALTON RAILWAY.

The Baldwin Locomotive Works have delivered new passenger locomotives to the Chicago & Alton Railway to be used in the expected heavy passenger service between Chicago and St. Louis in connection with the approaching exposition. These locomotives should admirably supplement the very large 4-6-2 type engines by the same builders, which were described on page 87 of the March number of this journal. The principle characteristics of the new 4-4-2 type are as follows:



HEAVY NEW PASSENGER LOCOMOTIVE—4-4-2 TYPE (ATLANTIC).—CHICAGO & ALTON RAILWAY.

Baldwin Locomotive Works, Builders.

4—4—2 TYPE PASSENGER LOCOMOTIVE, CHICAGO & ALTON RAILWAY.

Ratios.

Heating surface to cylinder volumes	= 321.9
Tractive weight to heating surface	= 31.9
Tractive weight to tractive effort	= 4.35
Tractive effort × diameter of drivers, to heating surface	= 586.
Heating surface to tractive effort, per cent	= 13.65
Total weight to heating surface	= 56.6

Gauge	4 ft. 8½ ins.
Cylinder	20 x 28 ins.
Valve	Balanced piston
Boiler—Typo	Straight; Material, steel
Diameter	70 ins.
Thickness of sheets	⅝ ins.
Working pressure	200 lbs.
Fuel	Soft coal
Firebox—Material	Steel
Length	108⅛ ins.
Width	72¼ ins.
Depth	Front, 71⅜ ins.; back, 57⅞ ins.
Thickness of sheets:	
	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.
Water space	Front, 4½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes—Material	Iron; wire gauge No. 11
Number and Diameter	326; 2¼ ins.
Length	16 ft.
Heating Surface—Firebox	191.2 sq. ft.
Tubes	3,056 sq. ft.
Total	3,247.2 sq. ft.
Grate area	54.2 sq. ft.
Driving Wheels—Diameter outside	80 ins.
Diameter of center	73 ins.
Journals	10 x 12 ins.
Engino Truck Wheels (Front)—Diameter	36 ins.
Journals	6½ x 12½ ins.
Trailing Wheels—Diameter	48 ins.
Journals	8 x 12 ins.
Wheel Base—Driving	7 ft. 8 ins.
Rigid	15 ft. 8 ins.
Total engino	27 ft.
Total engine and tender	56 ft. 3½ ins.
Weight—On driving wheels	103,690 lbs.
On truck (front)	40,130 lbs.
On trailing wheels	40,000 lbs.
Total engine	183,820 lbs.
Total engine and tender (about)	340,000 lbs.
Tank—Capacity	8,400 gals.
Tender—Wheels—Number	8
Diameter	36 ins.

FOUR-CYLINDER COMPOUND LOCOMOTIVES.

BY ALFRED G. DE GLEHN.

This subject is increasing in importance because the 4-cylinder compound stands for an effort to increase the efficiency of locomotives. This journal is indebted to *The Engineer*, London, for this able article by Mr. de Glehn.

So much has been written on compound locomotives in general, and on 4-cylinder compounds in particular, that I fear that the following note on the subject will contain nothing that is new. My only excuse for writing on the matter is that I have been for the last fifteen years in a position to have had exceptional opportunities for watching and helping in the evolution of the type of engine which has been too exclusively associated with my name. It is true that the 4-cylinder compound bearing the Northern of France Company's No. 701, which was the starting point of the type which I should wish to consider in the following note, was designed by me, but in the subsequent development of the engine I wish it to be clearly known that a very large part has been played by the Northern of France Company and the distinguished and liberal-minded engineers who have had charge of the rolling stock, and foremost among these, to mention their present well-known locomotive superintendent, Mons. Du Bousquet.

It is needless to go over old ground and to describe the successive developments of the type, and I will in the following confine myself to a general description of the engine as we are building it now, and to an examination of the reasons that have conduced to its extended use on the Continent. That the system does present marked advantages, in spite of its so-called complication, would seem to be conclusively proved by the fact that 1,500 locomotives of this type are at present either running or building and that their number is extending daily, not only in France, but on the Continent generally.

Whether the engine be a 4, 6, or 8-coupled one, the general principle subsists, namely (1) that the high-pressure cylinders drive one axle, and the low-pressure cylinders another, the coupling rods between tnese two driving axles having hardly any other function than to maintain the proper relative positions of the crank pins; (2) that for each pair of cylinders there is a complete valve gear as usual, with the usual weigh-shaft; these two weigh-shafts being worked at will, either together or separately by the usual reversing wheel, which sets in motion a screw in two halves, on each of which is a nut connected by a weigh bar with one of the weigh-shafts; (3) that by means of a special valve placed between the high-pressure exhaust and the low-pressure steam chest the high-pressure exhaust can pass directly to the main exhaust, which, with the simultaneous admission of live steam to the low-pressure

cylinders, results in converting the engine for the time into what may be termed two simple engines. The advantages resulting from these arrangements have been often set forth:

Division of stresses.—With the increasing power required for locomotives, it becomes more and more difficult, as every designer knows, to give sufficient wearing surfaces to the different parts for the transverse dimensions of the engine to remain limited, and thus the length of the wearing surfaces is limited also. With the system under consideration there is an outside-cylinder engine and an inside-cylinder engine, each doing about half the total work. For each half of this work there is, therefore, the space usually available in an outside or inside-cylinder engine having to do the whole work. The motion parts can therefore be made very light, and yet with very large wearing surfaces. The two low-pressure cylinders which are inside the frames, save in exceptional cases, drive the crank axle; and, as in normal running, the low-pressure cylinders do somewhat less than half the total work, the crank axle, in so far as its fatigue comes from the steam engine proper, is relieved of more than half that which it has to bear in an ordinary engine. The division of the stress is carried through to the valve gear, and this has been frequently criticised as a needless complication. If we are willing to sacrifice a good deal of economy in steam to more or less apparent simplification, we can, as has been recently done in America, place the four cylinders one by the side of the other and distribute the steam by two piston valves, one on each side, thus having only two valve gears. This arrangement entails, in most cases, either connecting all four cylinders to the crank axle, thus giving it all the work to do, which seems a pity; or inconveniently short inside and inconveniently long outside rods. The cylinder casting becomes extremely complicated. The piston valve if tight is heavy to move, and therefore, fatiguing for the gear; or, if easy to move, is not tight, and, besides, passes alternately high and low-pressure steam—that is, of very different temperatures—and is therefore a source of loss, and, last but not least, till the ideal compressible piston valve be found, entails relief valves on all the four cylinders. The losses by these valves and their rapid wear are but too well known.

Von Borries has lately tried an arrangement in which the four cylinders, each with separate steam chest and valve, are placed one by the side of the other, all four cylinders driving one axle—the crank axle. There are two valve gears, one on each side, actuating the high and low pressure on that side by means of a rocking shaft arrangement giving a varying, but definitely varying, ratio of expansion in these two cylinders. The simplification is more apparent than real, and here again more stress is put on the crank axle and the valve gear than seems advisable with the continually increasing power of modern locomotives.

The only obection that can be made to the four valve gears is the slightly increased first cost of the engine, and this is most certainly compensated by their reduced wear, increased security against breakdowns, and the adaptability they allow to the varying running conditions.

Leaving now this peculiarity of the system, that the division of the total work to be done is carried throughout the engine, not only as far as the axles and propelling gear are concerned, but also to the valve gear, I come to the next point:

Balancing of the revolving and reprociting parts.—Here, again, this question becomes of more and more importance and difficulty owing to the immense increase in the power of modern engines, and the ensuing great weight of all its parts. In goods engines the comparatively small wheels make the placing of adequate balance weights extremely difficult, and for the very fast running now required from express engines a correct balance becomes more and more indispensable for security, while it is more and more difficult with ordinary engines to keep the variations between maximum and minimum pressures of the wheels on the rails within reasonable bounds.

In the system under discussion the need for using revolving weights for the purpose is done away with. The low-pressure cylinders are, save in exceptional cases, inside the frames. The weights of the reciprocating parts of the low-pressure engine, as it may be called, are greater than the corresponding parts of the high-pressure engine which lie outside the frames; but as the transverse distance between their planes of movement is at the same time less than that between the planes of movement of the outside lying parts, their moments may be made to be very nearly equal, and thus the need for weights to balance the reciprocating parts is done away with. There remains, then, no difficulty in providing for the balancing of the revolving weights, each pair of wheels having its proper balance. It will be seen from the foregoing that in four-coupled express engines on this system the coupling rods are relieved of all stresses, except those necessary to keep the two driving axles in their proper relative position, and to transmit from rear to front axle the slight excess of the work done by the high-pressure over that by the low-pressure cylinders.

In electric motor-driven vehicles the adhesive weight is, as is well known, better utilized than in ordinary two-crank engines, owing to the uniformity of the turning moments. In the engines that I am describing with the four cranks set at 90 deg., the turning moments are, of course, much more uniform than in ordinary engines, and approximate practically very closely to the results obtained by a motor drive. Another advantage of the four cranks is the ease and certainty in starting, and this is further enhanced by the intercepting valve, which enables the driver to work each pair of cylinders with direct exhaust and live steam from the boiler, thus increasing by about 25 per cent. the tractive power of the engine, which can thus start with more certainty, and get up speed more quickly, than an ordinary engine.

I come now to the question of water and fuel economy. Of the economy there is, of course, no doubt; it is its amount concerning which no general assertion can be made owing to the widely varying conditions of locomotive work and the difficulties of getting really proper terms of comparison. It suffices to say that it may be taken as roughly 10 to 12 per cent. all round. This, calculated as money saved per year and per engine, will not appear a large sum, and would most certainly not justify much increase in first cost, in repairs and in liability to break down—in a word, what is generally meant when the word "complication" is used. Nor would it compensate for increased difficulty in starting or unsteadiness in running. But with compounding under this form we get the economy, and an improvement under all the other heads. The truth of this statement will probably be now generally admitted, except, perhaps, as regards the first cost, but it can be proved that per horse-power this type of engine can be made as cheaply, if not more cheaply, than an ordinary engine. One drawback must be mentioned, as I wish to be perfectly fair. There is, in some cases, an increase in oil consumption, this being due to the increased number of parts, each oil hole using a certain quantity of oil usefully and a certain quantity being wasted. The oil used usefully will be proportional to work done, approximately; the waste will not, and this will figure against the system.

It has frequently been said that it is not in the system that the advantages claimed lie, but in the high pressures used. These high pressures most certainly do play a very important part; but it is the system, in a great measure, that has enabled us to use these high pressures without their entailing too much trouble with slide valves, etc., and I may further state that the first four-cylinder compound built in 1885 for the Northern of France had only 157 lb. pressure, and is still as economical in fuel as the later types with pressures of 228 lb.

I have tried to show as plainly and fairly as possible the advantages of the system, and would merely wish to add that it has enabled us to do, on the Continent, work for which in America recourse has been had to enormously heavier engines. What economy would result as regards permanent-ways, bridges, round houses and plant in general, from using for the same work to be done, properly balanced, divided compound engines as well for goods as for passenger traffic, in the place of imperfectly balanced engines some 20 per cent. heavier and larger, it would be difficult to estimate, but an attempt to do so would show pretty clearly a very good case for the divided balanced compound four-cylinder engine.

MOTOR-DRIVEN MACHINE TOOLS.

INTERESTING APPLICATIONS OF ELECTRIC DRIVING TO MILLING MACHINES.

(*Continued from page* 424.)

In this article are presented further examples of the application of motor-driving to milling machines. Considerable attention has been paid to the subject of equipping milling machines electrically, as particularly adapted to individual driving, on account of the varied classes of machining service usually handled. Much has been learned in this important subject by the equipment of this class of machine tools with motors, and special attention should be given to the following examples:

The Becker-Brainard Milling Machine Co., Hyde Park, Mass., have devoted particular attention to this subject both for their plain and universal and for their well-known vertical type of millers. Supplementary to the photo of their motor-driven universal miller, which was reproduced on page 423 of the preceding article, we show, in Figs. 6, 7 and 8, drawings of motor drive arrangements as applied to their No. 3 plain miller and to their No. 6 vertical millers. These drives are conveniently and neatly arranged and undoubtedly represent the best practice in this line.

Fig. 6 illustrates the arrangement used by the Becker-Brainard Company in equipping their No. 3 new model plain milling machine for motor driving. The motor is mounted upon a neat, strong cast iron bracket which is bolted to the side of column, and connection is made by belt to a counter-shaft supported by a bracket at the top of the column; From this shaft a belt drive is made to the main spindle using the ordinary four step cone. This style of drive can be used with either a constant-speed or a variable-speed motor. With a constant-speed motor it allows a range of speeds sufficient for ordinary manufacturing purposes, while with a variable-speed motor it provides the much greater range of speeds that is desirable for special work.

The objection has been made to this method of arranging a drive that the bulk of the motor applied at this point will render the machine top-heavy; but the appearance of this application tends to prove the contrary. The effect given by this design is that of a neat and compact design, with little extra space occupied by the motor. An important feature of this method is that a standard machine may be thus equipped without alterations other than that of applying the necessary brackets for the motor and the small countershaft.

Fig. 7 illustrates a method of applying a motor drive to the No. 6 vertical Becker-Brainard milling machine, as arranged for use with a constant-speed motor. The motor is in this case, mounted on a heavy cast-iron bracket, fastened to back of column and securely braced. The driving connection is made to the spindle through belt and gearing, and then a belt and three-step-cone drive, as in the regular machine. This arrangement is found to give a very powerful drive, and it makes a compact equipment. Owing to the massive and solid design of the frame of this tool, no effect of top-heaviness is produced, but rather a most natural result is obtained.

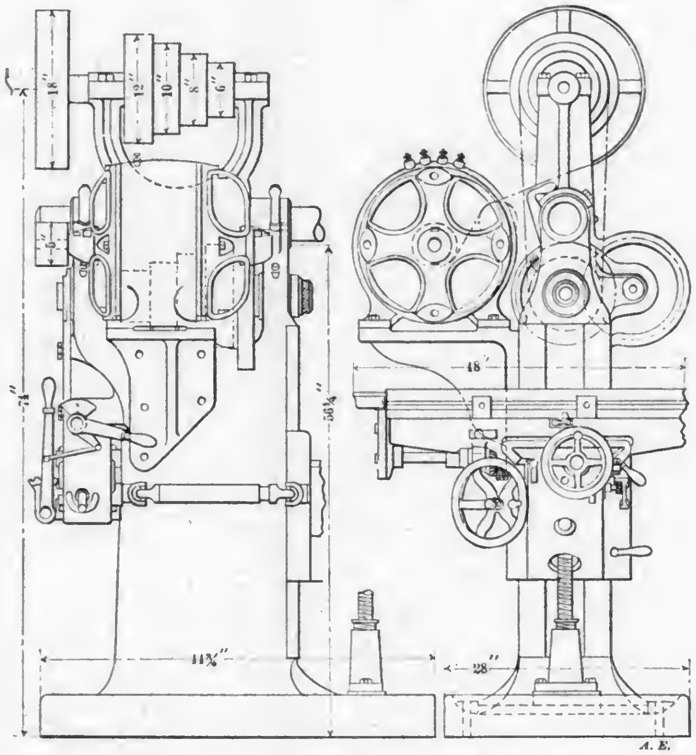


FIG. 6.—SIDE BRACKET DRIVE FOR A PLAIN MILLING MACHINE.

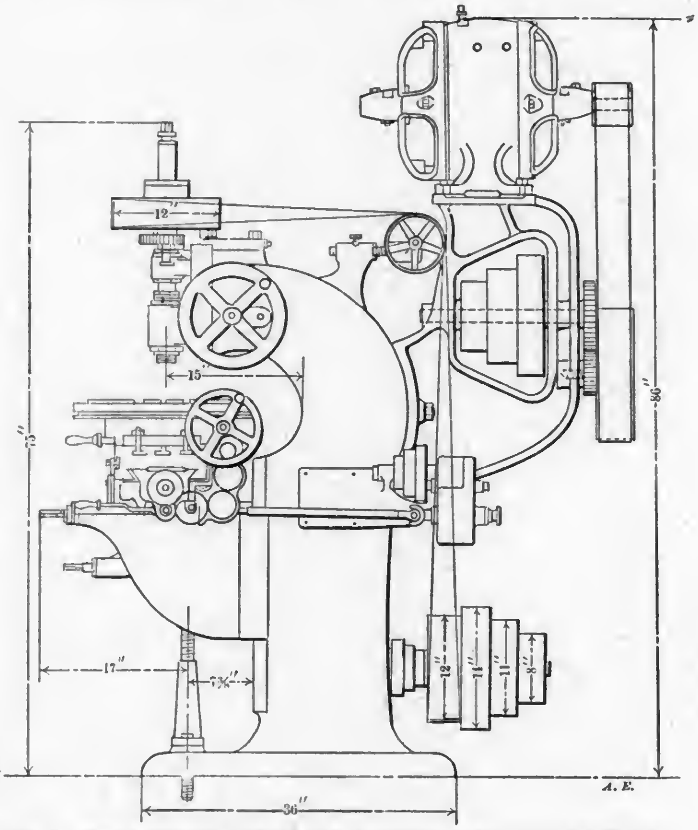


FIG. 7.—BACK BRACKET DRIVE FOR A VERTICAL MILLING MACHINE.

MOTOR-DRIVEN MILLING MACHINES.BECKER-BRAINARD MILLING MACHINE COMPANY.

Particular attention should be given to the heavy design of the motor support bracket. It is heavily webbed for stiffness and strength, and vibration is prevented by a rod brace carried from the top over to the top of the tool's frame. The speed reduction from the motor is obtained by gearing at the end of the upper speed cone, as shown in the drawing; a silent chain drive could have been used from the motor direct to the upper cone shaft, with equally good, if not better results.

In Fig. 8, is shown another method of applying a motor drive to the No. 6 Becker-Brainard vertical miller. It is, in this case, arranged for a variable-speed motor, which is mounted on an auxiliary base at the rear of the machine. The speed cones are here eliminated and connection to the main spindle pulley is made direct through back gears and belt from the motor shaft. This arrangement has been found very satisfactory for use where floor space is not so important, and a larger range of speeds is desired than can be supplied with constant-speed motor.

The motor support is a separate base, which is merely tied to the frame of the tool. It carries the back gears as an entirely separate unit from the remainder of the tool and the

motor and gearing are in this arrangement kept far removed from metal cuttings and other dirt from the machine. The very desirable feature of this equipment is also that it can be applied to the standard tool, thus permitting a motor-driven tool to be had at the least possible excess of cost over that of the standard tool and countershaft—this is a most important feature of the individual drive problem.

An interesting arrangement of milling-machine driving is shown in the engravings, Fig. 9 and Fig. 10, which illustrate an induction motor drive upon the 42-inch combined horizontal and vertical spindle milling machine built by the Ingersoll Milling Machine Co., Rockford, Ill. This is a very compact drive for a tool of this size, the motor being arranged upon a floor plate at one side (see Fig. 10) of, and bolted to the frame, from which position it drives through gearing. A limited range of speeds is furnished by gearing changes at the motor, other changes being of course, provided at the spindle and feeding drives. The motor is of 25 h.p. capacity.

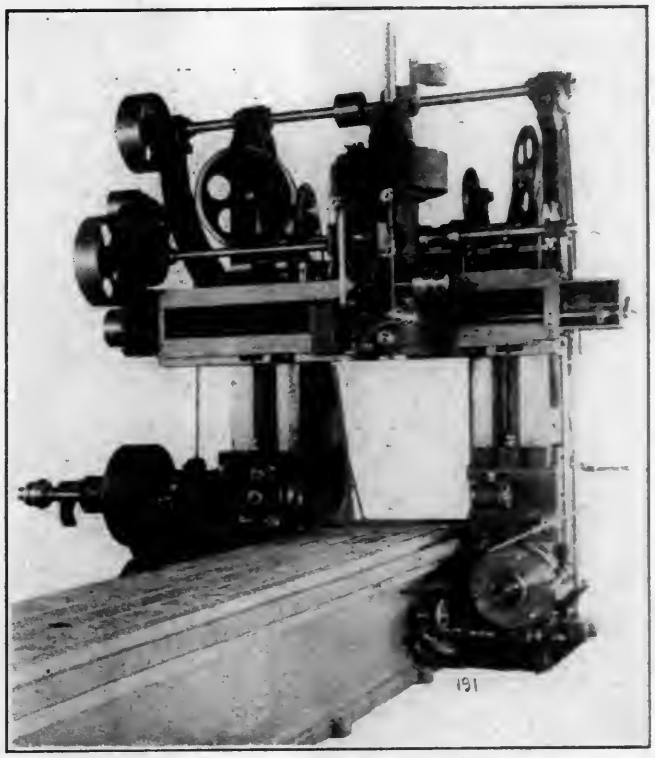


FIG. 9.—THE 42-INCH COMBINED HORIZONTAL AND VERTICAL SPINDLE MILLING MACHINE, MOTOR-DRIVEN.—INGERSOLL MILLING MACHINE CO.

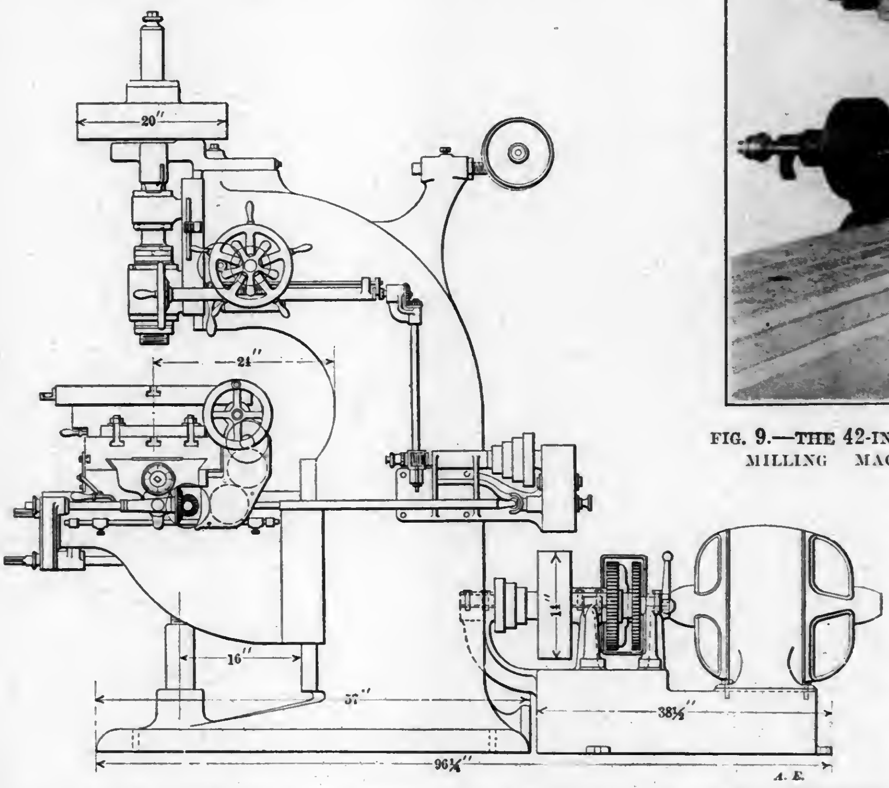


FIG. 8.—FLOOR MOTOR DRIVE AS APPLIED TO A BECKER-BRAINARD VERTICAL MILLING MACHINE.

On this particular tool the use of an electric motor has greatly simplified the question of driving; the multiplex nature of the drive is such that great flexibility is necessary, which is possible only with the electrical method of driving.

Supplementary to the description of the Bement, Miles slab milling machine, with a complex drive, presented in the previous article (page 424), we are permitted to here illustrate another similar machine of the same make. This tool, illustrated in Fig. 11, is the No. 6 Bement, Miles & Co. horizontal milling machine, which has a capacity of milling to a size of 37½ x 37½ inches.

It is equipped with their standard arrangement of motor driving in which a gear box is used for obtaining variable speeds. The gear box is clearly shown at the right and in front of the motor, which is a Crocker-Wheeler direct-current constant-speed motor. A wide range of driving speeds are provided by this gear box, thus making a very flexible drive.

One of the latest and neatest schemes for providing milling machines with a contained motor drive is illustrated in Fig. 12. It represents the geared-feed milling machine, built by the Brown & Sharpe Manufacturing Company, corresponding very closely with its No. 1 universal milling machine. Power is supplied by a Crocker-Wheeler semi-inclosed shunt-wound motor and the speed regulation is afforded by a Crocker-Wheeler 12-point controller, designed to operate on the 4-wire multiple-voltage system, giving six speeds by voltages ranging from 40 to 240 by increments of 40 volts each and an equal number of intermediate speeds by resistances. In all twelve speeds in either direction are made convenient, and instantaneously available by means of the controller, which is most conveniently located for the operator.

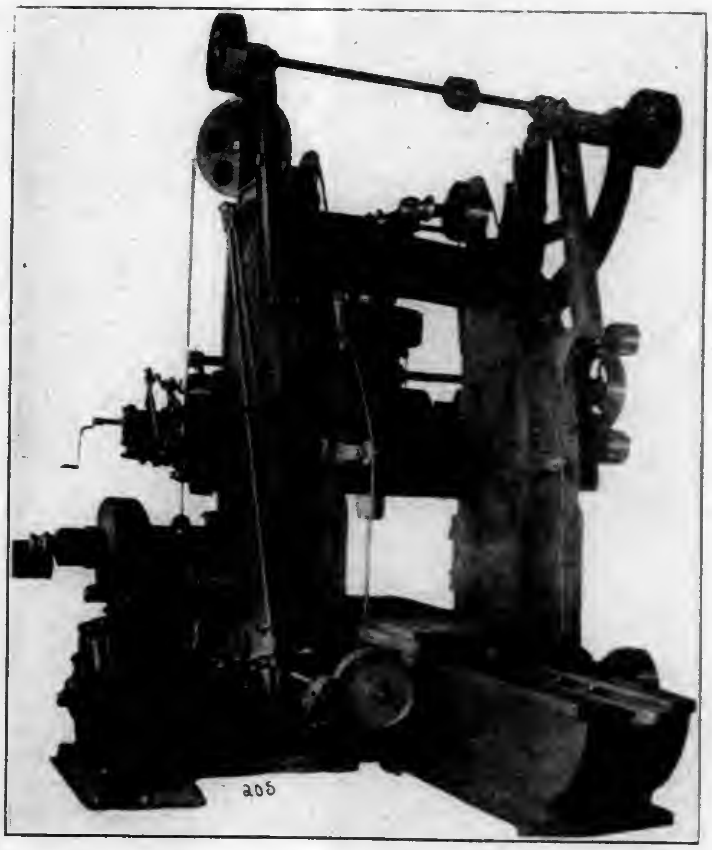


FIG. 10.—REAR VIEW OF THE INGERSOLL MILLING MACHINE, SHOWING ARRANGEMENT OF MOTOR AND DRIVE.

This tool was designed especially for light rapid work, such as the finishing of small brass parts, so that it required a motor of only 3 h.p. The speed reduction from motor to tool is about 3½: 1. the lowest speed of the motor rotating the spindle at 44 rev. per min., and the highest speed at 276. With the extreme limits of the table travel, the machine requires a floor

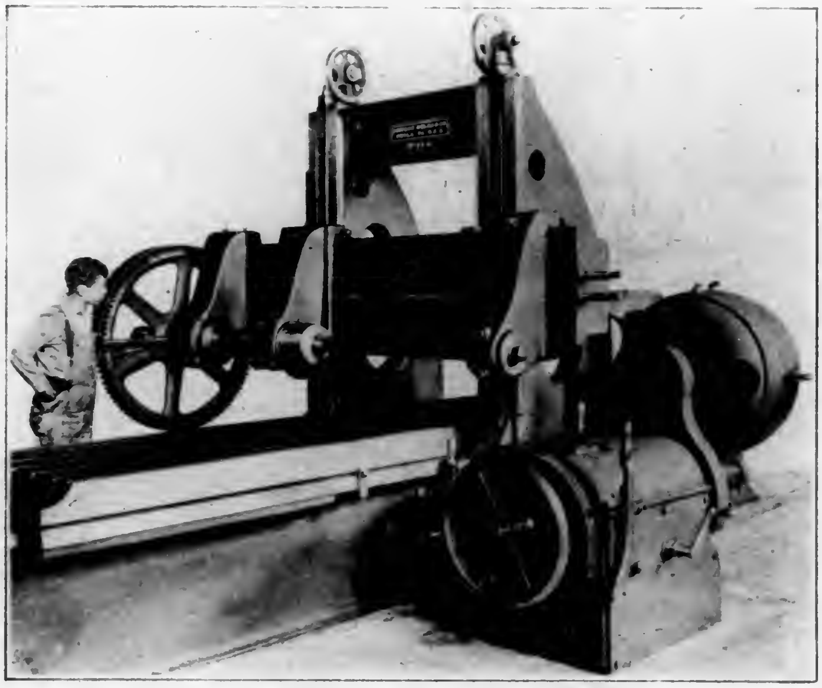


FIG. 11.—VARIABLE-SPEED MOTOR DRIVE, USING GEAR MECHANISM, FOR BEMENT, MILES & CO., SLAB MILLING MACHINE.—CROCKER-WHEELER MOTOR.

space only 86 ins. wide by 44 ins. in line with the spindle, and an over all height of the motor as located above the machine is

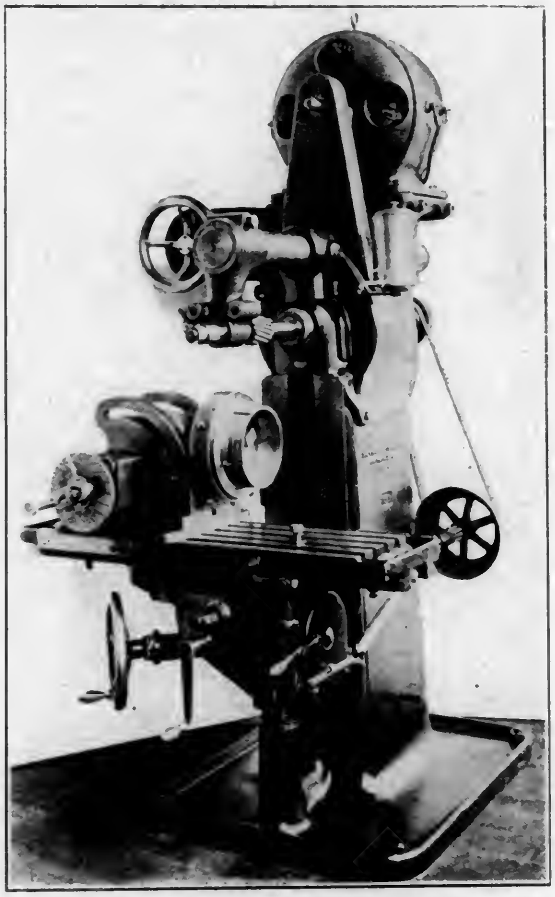


FIG. 12.—VARIABLE-SPEED DRIVE FOR A BROWN & SHARPE UNIVERSAL MILLING MACHINE.—ALL PARTS ENCLOSED.—CROCKER-WHEELER MOTOR.

but 6 ft. 4 ins., so that the motor is at all times easily accessible for inspection or adjustment.

LIMITS OF WEAR OF CROSSHEAD PINS.

A correspondent writes as follows:

"I would deem it a great favor if you will furnish me with references to articles in the AMERICAN ENGINEER concerning the designing of bearings in locomotive crossheads. What I wish particularly is to establish a limit for wear of crosshead pins of either cast steel or cast iron and used with locomotives having cylinders of different sizes."

This subject has not been treated fully in the way outlined by this correspondent and the reply to his letter may perhaps interest others.

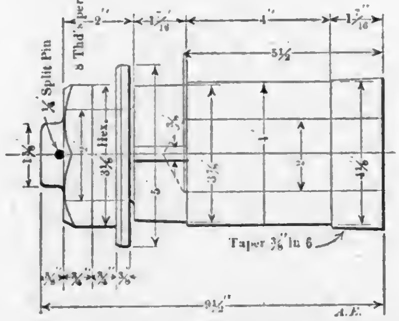
In the case of crosshead pins, which are in double shear, the bearing surface of the brass becomes the limiting factor. Assume a locomotive with 20-in. cylinders, having 314.16 sq. ins. piston area. With 200 lbs. pressure the load on the crosshead pin, from the steam alone, disregarding the effect of water in the cylinders, is 314.16 x 200, or 62,832 lbs.

Let us assume two sizes of pins, the first being 3.75 ins. in diameter and the second 3.5 ins., the length being 3.5 ins. in both cases. The projected area of the 3.75-in. pin is 13.125 sq. ins. The projected area of the 3.5 pin is 12.25 sq. ins. The unit stress in the first case is 62,832 divided by 13.125 or 4,787 lbs, per sq. in. For the smaller pin the unit stress is 62,832 divided by 12.35 or 5,129 lbs. per sq. in.

In this case a pin 3.75 ins. in diameter will be satisfactory for a new engine and an allowance of ¼ in. for wear may be safely made and yet the unit stress be kept within reasonable limits. One of the plants now included in the American Locomotive Company used a unit stress of 4,200 on new pins; another one uses 4,800 lbs. It seems to be good practice to allow these pins to wear until the load becomes about 5,000 lbs. per sq. in.—this is a safe figure.

On main crank pins the load per square inch of projected area should not be greater than from 1,600 to 1,700 lbs., the load being computed for simple engines by multiplying the piston area by the boiler pressure and for compound engines by multiplying the low pressure piston area by the boiler pressure and dividing this product by the cylinder ratio plus 1.

The unit of wear on a crosshead pin is reached first by the ability of the pin to remain in service without getting hot before the matter of structural strength becomes a factor, and if the pins are made sufficiently large to begin with to give



about ¼ in. wear before the unit stress becomes more than 5,000 lbs. per sq. in., the results will be satisfactory.

This engraving illustrates the crosshead pins of a locomotive with 22 x 28-in. cylinders. This pin has a 4 x 4-in. bearing surface with a projected area of 16 sq. ins. At 180 lbs. pressure the total load is 68,423 lbs., or 4,276 lbs. per sq. in. The same crosshead was used on another engine with 22-in. cylinders, having 200 lbs. pressure, which increased the load to 4,750 lbs. Of course these pressures are not constant, as the strain is very much reduced while running at speed with the mean effective pressures reduced.

HYDRAULIC DROP TABLE.

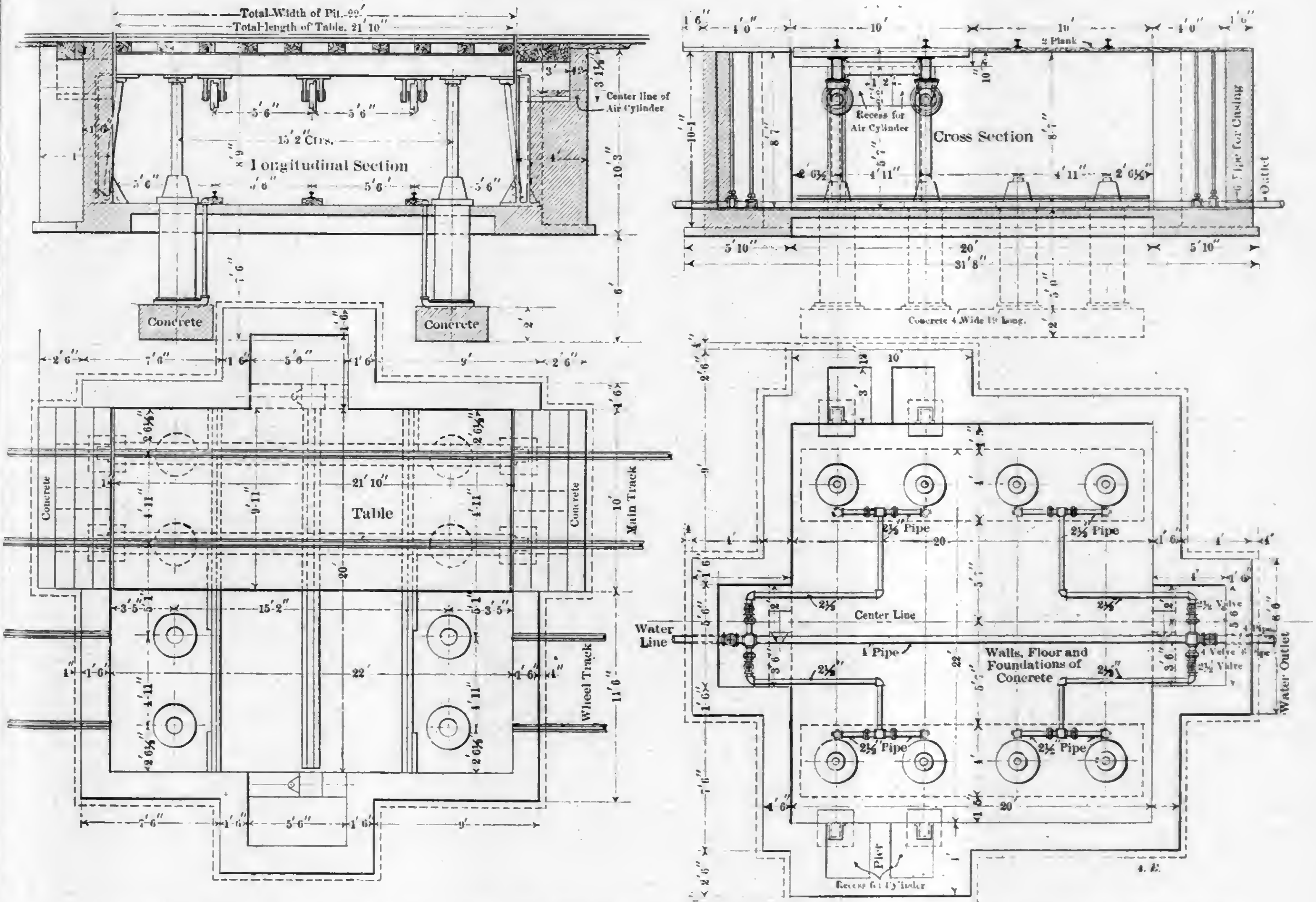
AT SHERIDAN, WYOMING.

BURLINGTON & MISSOURI RIVER RAILROAD.

At Sheridan, Wyo., a division point of the Burlington & Missouri River Railroad, is installed a very unique and useful hydraulic drop pit and table, which was designed to meet the requirements necessary for handling heavy engines at small repair shops where the plan of shop did not permit the use of traveling cranes.

The principal feature of this drop table is that it is possible with pneumatic pressure there might be a liability of failure and consequent serious accident or delay. To further prevent possible failure two locks were placed at each end of the transfer table, one under each track, as indicated in the longitudinal section. These locks are pushed into position by a small air cylinder before the engine passes over the table. It will be noticed that the transfer table is provided with track wheels on the under side. These are used for transferring the table from the left hand to the right hand cylinders, and vice versa. A general plan of the house is shown in the lower engraving.

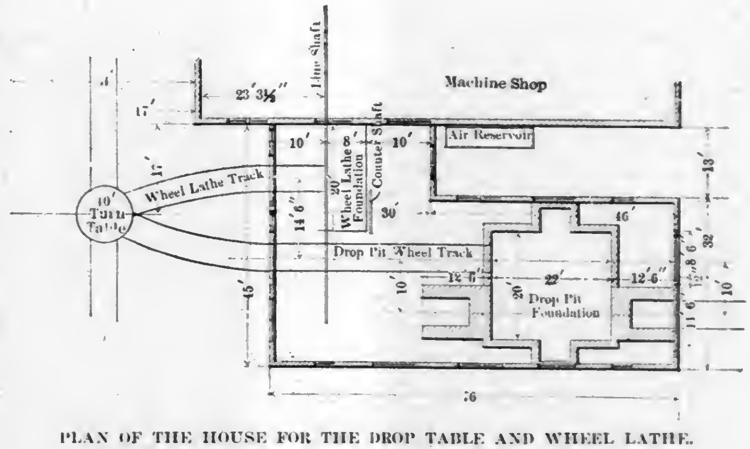
The method of operation is as follows: The transfer table is moved into position over the four cylinders at the left hand side of the pit and pressure turned on from the water main. It will be noticed below that each pair of cylinders have



SECTIONS AND PLANS OF HYDRAULIC DROP TABLE FOR DRIVING WHEELS AT SHERIDAN, WYO.—BURLINGTON & MISSOURI RIVER RAILWAY.

to drop one pair or all drivers from the lightest or heaviest engine and transfer them from the engine to the wheel lathe with the least amount of labor, the lathe being conveniently located in the same building. On account of the nature of the ground it was found necessary to completely enclose the pit with concrete walls and floor, water having been found at a depth of 5 ft. from the surface. The plant consists of eight cylinders embedded in the ground on concrete foundations, and a transfer table. These cylinders are located as shown in the section views, four cylinders being used on one side to carry the transfer table when the engine passes over, while the four cylinders on the other side are used to elevate the transfer table and load to the level of the wheel track. The longitudinal section of the pit illustrates the transfer table in position for an engine to pass over it.

Hydraulic pressure was preferred for the power for raising the pistons on account of its uniformity, as it was feared that



PLAN OF THE HOUSE FOR THE DROP TABLE AND WHEEL LATHE.

This tool was designed especially for light rapid work, such as the finishing of small brass parts, so that it required a motor of only 3 h.p. The speed reduction from motor to tool is about 3½ : 1, the lowest speed of the motor rotating the spindle at 11 rev. per min., and the highest speed at 276. With the extreme limits of the table travel, the machine requires a floor space only 86 ins. wide by 41 ins. in line with the spindle, and an over all height of the motor as located above the machine is but 6 ft. 1 ins., so that the motor is at all times easily accessible for inspection or adjustment.

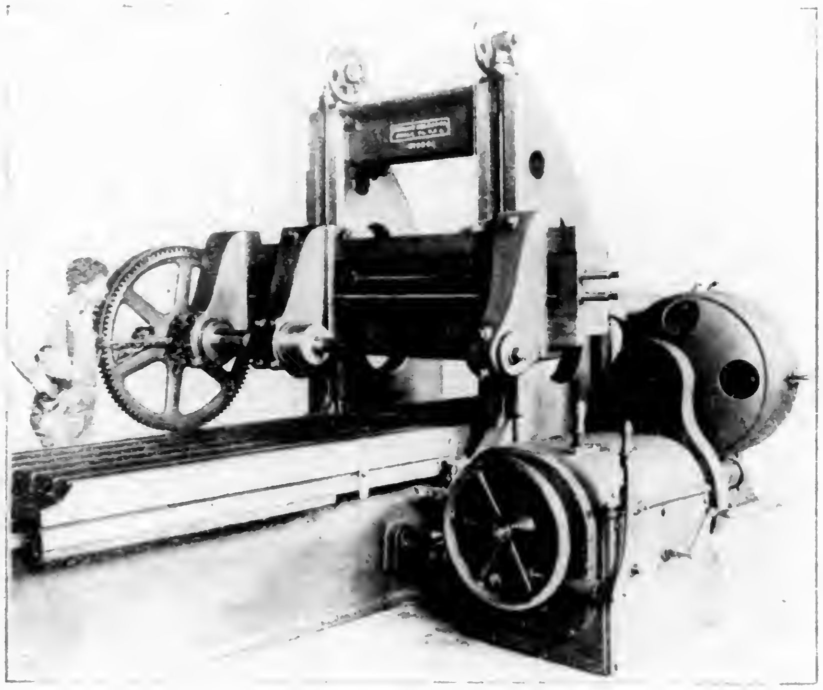


FIG. 11.—VARIABLE-SPEED MOTOR DRIVE, USING GEAR MECHANISM, FOR BEMENT, MILES & CO., SLAB MILLING MACHINE.—CROCKER-WHEELER MOTOR.

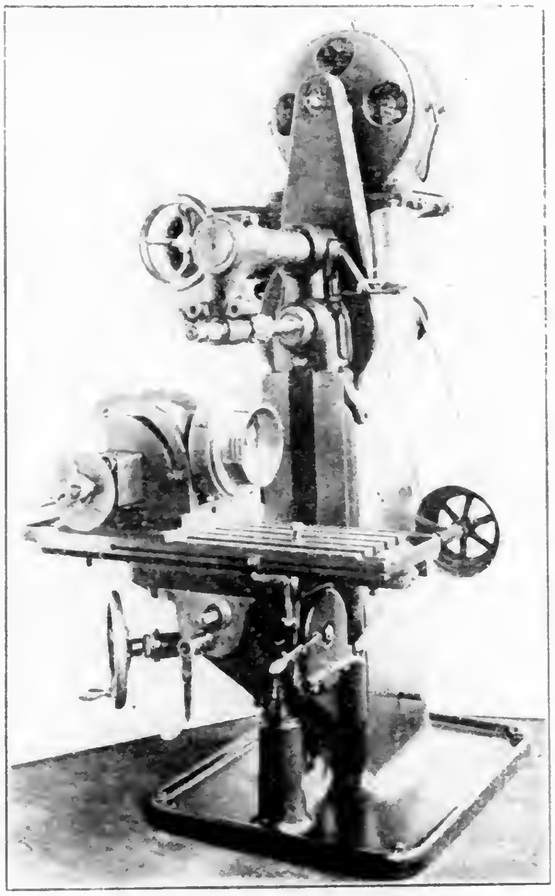


FIG. 12.—VARIABLE-SPEED DRIVE FOR A BROWN & SHARPE UNIVERSAL MILLING MACHINE.—ALL PARTS ENCLOSED.—CROCKER-WHEELER MOTOR.

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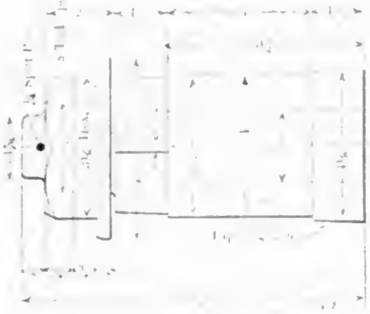

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HYDRAULIC DROP TABLE.

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Burlington & Missouri River Railroad.

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The principal feature of this drop table is that it is possible to drop one pair or all drivers from the lightest or heaviest engine and transfer them from the engine to the wheel lathe with the least amount of labor, the lathe being conveniently located in the same building. On account of the nature of the ground it was found necessary to completely enclose the pit with concrete walls and floor, water having been found at a depth of 5 ft. from the surface. The plant consists of eight cylinders embedded in the ground on concrete foundations, and a transfer table. These cylinders are located as shown in the section views, four cylinders being used on one side to carry the transfer table when the engine passes over, while the four cylinders on the other side are used to elevate the transfer table and load to the level of the wheel track. The longitudinal section of the pit illustrates the transfer table in position for an engine to pass over it.

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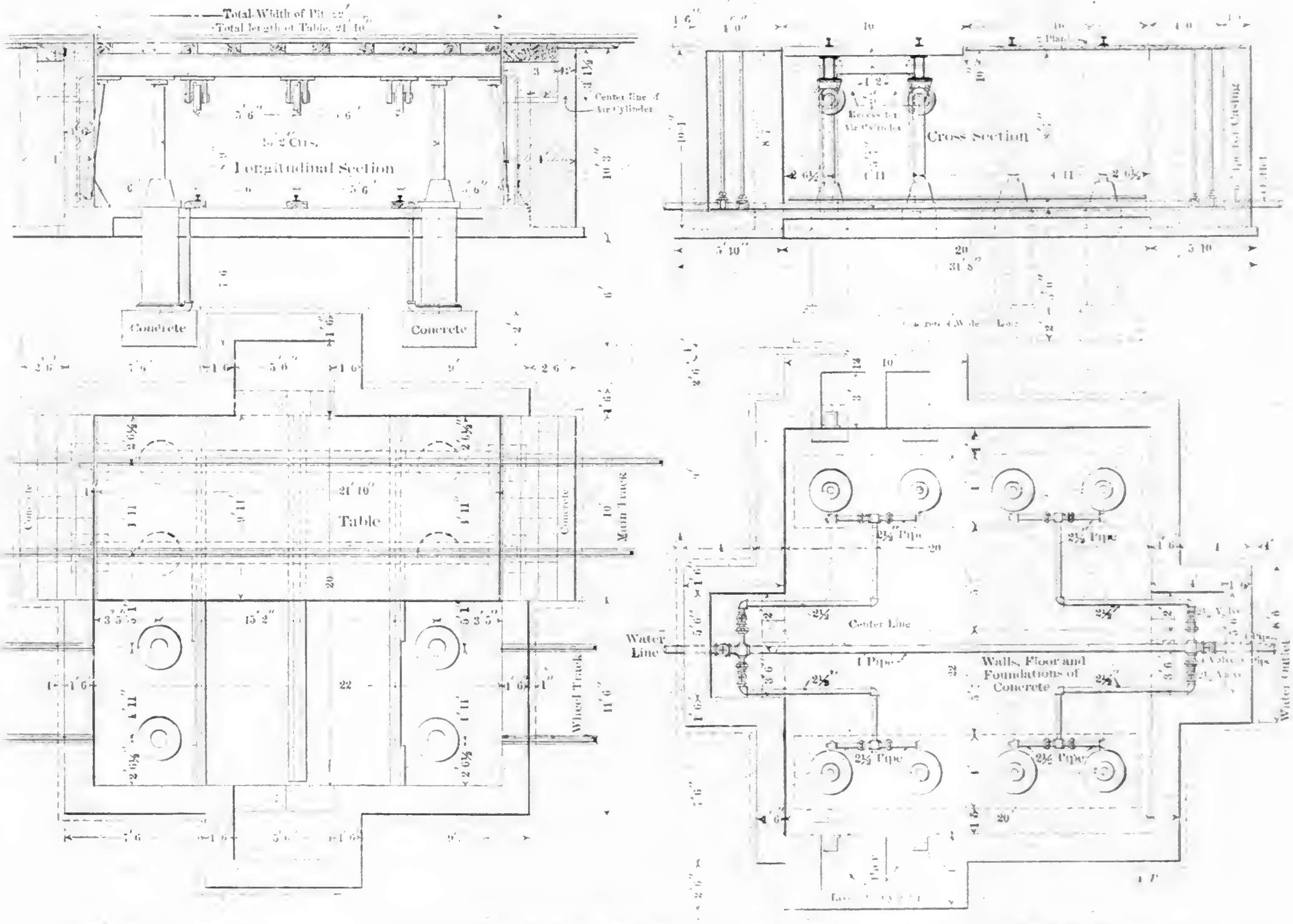
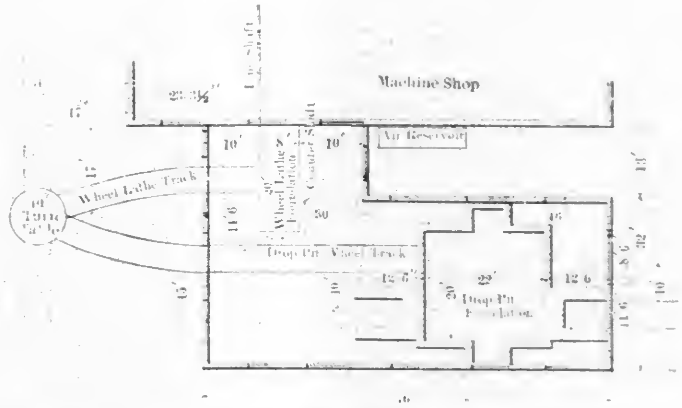


SECTIONS AND PLANS OF HYDRAULIC DROP TABLE FOR DRIVING WHEELS AT SHERIDAN, WYO.—BURLINGTON & MISSOURI RIVER RAILWAY.



PLAN OF THE HOUSE FOR THE DROP TABLE AND WHEEL LATHE.

their own valve. By this means difference in movement of cylinders can be controlled by the operator and the table raised level. As soon as the table is in position the air is turned on to the locking cylinders and the locks put into position. The water pressure can be turned off, if desired, and table will rest on the locks. The engine is now pushed across the table until the truck stands clear and it is possible to put jacks under the rear end. Jacks are then put under in front and rear to steady the engine and take the weight off the table. The water pressure is turned on and the table rises just enough to raise the drivers clear. If the engine is to be sent to the shop for repairs the wheels are dropped down and the table transferred to the position over the four cylinders at the right hand side of the pit, after which it is raised to the level of the rails and the wheels rolled off to the wheel track. This done, a specially designed truck is rolled on the table and the latter returned to its position under the engine, the truck being then placed under the rear end and engine jacked down. It is then ready to be pushed into the shop.

The hydraulic lifting cylinders are 20 x 60 ins. of cast iron, and the piston rods are 7½ ins. in diameter. The transfer table is 21 ft. 10 ins. long and is built up of 15-in. I-beams with diagonal bracing of angles. The rails are carried on 6 x 10-in. ties. A more carefully designed drop table equipment is seldom seen.

Mr. R. D. Smith, superintendent motive power, states that the heaviest locomotive thus far handled on this pit is of the 2-8-0 type, weighing 207,000 lbs. Forty minutes are required for removing the drivers of this engine when it is on the pit and stripped for the purpose. This includes blocking the engine, dropping the wheels, transferring, raising and rolling them off to the wheel tracks. The best record made is 20 minutes for dropping and placing a pair in the lathe ready for turning.

This table has saved quite an amount in labor when handling heavy wide firebox engines, and does away with the necessity of jacking up the engines as high and using as much blocking as would be necessary if all drivers had to be removed. The operation for one pair of drivers, of course, is quite simple, as the engine stands on the table until the drivers are replaced. The plans were prepared by Mr. E. W. Fitt, chief draughtsman of the road, and the plant was installed under the supervision of Mr. C. J. Saberhagen, division master mechanic at Sheridan.

THE CONVENTIONS FOR 1904.

The next annual convention of the Master Car Builders Association will be again held at Saratoga Springs, N. Y., June 22nd to 24th, 1904, inclusive, with headquarters at the Grand Union Hotel. The American Railway Master Mechanics Association will also hold their next annual convention at Saratoga Springs, June 27th to 29th, inclusive, with their headquarters also at the Grand Union Hotel. Applications for hotel accommodations should be made to Woolley & Gerrans, care of Hotel Marie Antoinette, 67th street and Broadway, New York City, up to May 1st, but after that date, to Woolley & Gerrans, Grand Union Hotel, Saratoga Springs, N. Y. Applications for exhibition space should be addressed to Mr. J. Alexander Brown, secretary, 24 Park Place, Room 17, New York City.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XI.

BY C. W. OBERT.

The Lodge & Shipley Machine Tool Co., of Cincinnati, O., have for some time past been applying to the various sizes of their line of lathes, a geared variable-speed feeding mechanism, which embraces the latest ideas of design in the line of variable-speed machinery. It is of interest particularly for the large number of speeds which it makes available at the lead screw for screw cutting and feeding; the various screw-cutting speeds are designed especially to produce the most desirable screw threads with exactness for each position of the handles, making the lathe most easy to handle. The mechanism is of a very compact design and is carefully located for protection to all working parts.

The details of the design, which the variable-speed mechanism used embodies, is made clear in the engraving, Fig. 51, and is shown as it appears, applied to the lathe in Fig. 52. The view of the headstock end of the lathe bed, Fig. 53, which is a plan

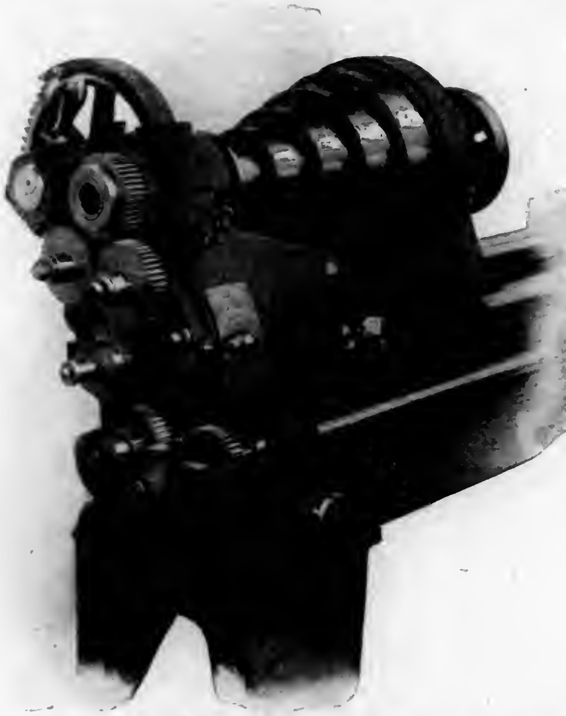


FIG. 52—VIEW OF THE HEADSTOCK END OF THE LODGE & SHIPLEY LATHE, SHOWING ARRANGEMENT OF THE VARIABLE-SPEED FEEDING MECHANISMS.

view, looking vertically downward upon the bed with the headstock removed, is of assistance in indicating the relative proportions of the mechanism.

This variable-speed mechanism is arranged in two parts as is indicated in Fig. 52. One is located beneath and within the headstock and has a capacity of eleven speeds, while the other, a four-speed device, is located at the end of the bed, outside, where connection is made with the lead screw. The portion within the headstock has direct connection with the lathe spindle, through gearing as shown at the end, so that it acts as the driving mechanism. This gearing is also capable of being changed so that extra ranges of speed changes may be obtained at the lead screw of the lathe, if needed.

The driving portion of the mechanism, which is located within the headstock, has a capacity of eleven different speeds, as applied to their lathes up to the 20-inch size. The speed changes are obtained by the cone of gears and shifting pinion principle; this is clearly shown in Figs. 51 and 53, in which the arrangement of the gear cone, as well as the tumbler, or rocker arm, carrying the shifting pinion, is made clear. The shaft to which the gears of the cone are keyed, extends through the

end of the bed and serves to deliver the drive to the outside portion of the mechanism.

The splined shaft upon which the shifting pinion tumbler slides is the driving member, as it is geared direct to the lathe spindle. The tumbler carries a sleeve surrounding and feathering with the splined shaft; upon one end of the sleeve is mounted a pinion, meshing with and serving to transmit motion to the shifting pinion at the end of the tumbler arm, which comes into contact with the gears of the cones. The sleeve has an ample area of key contact with the splined shaft, and has also a long bearing thereon for accuracy and stability.

The shifting pinion is dropped into mesh with any gear of the cone by merely lifting the knob on the other leg of the tumbler and bringing it to a locking position, as it is to be seen in Fig. 53. This opposite leg of the rocker is shaped to project out through the slot in the bed and up in front of the headstock, as shown:

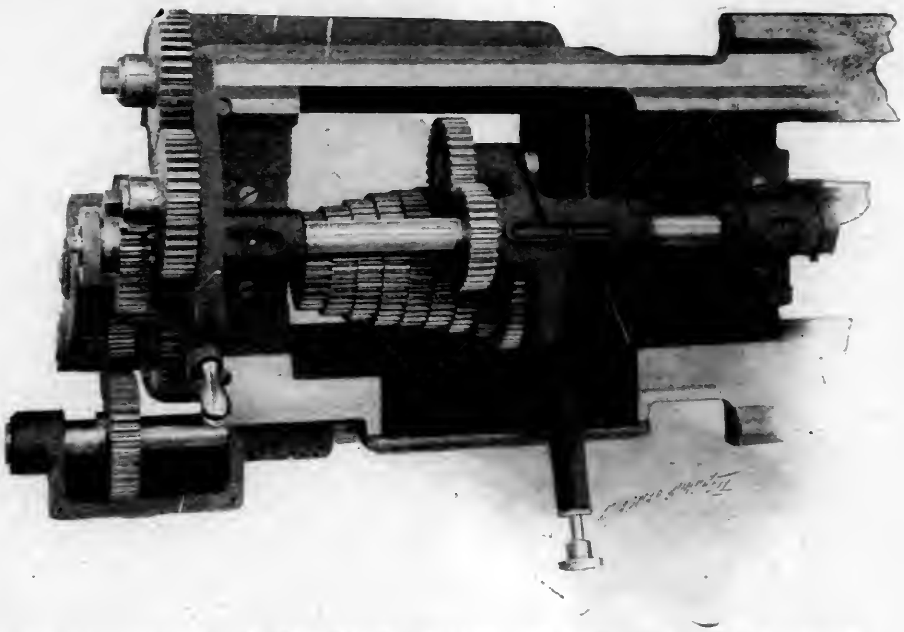


FIG. 53.—VIEW OF THE MECHANISM BENEATH THE HEADSTOCK, TAKEN LOOKING VERTICALLY DOWNWARD UPON THE LATHE BED.

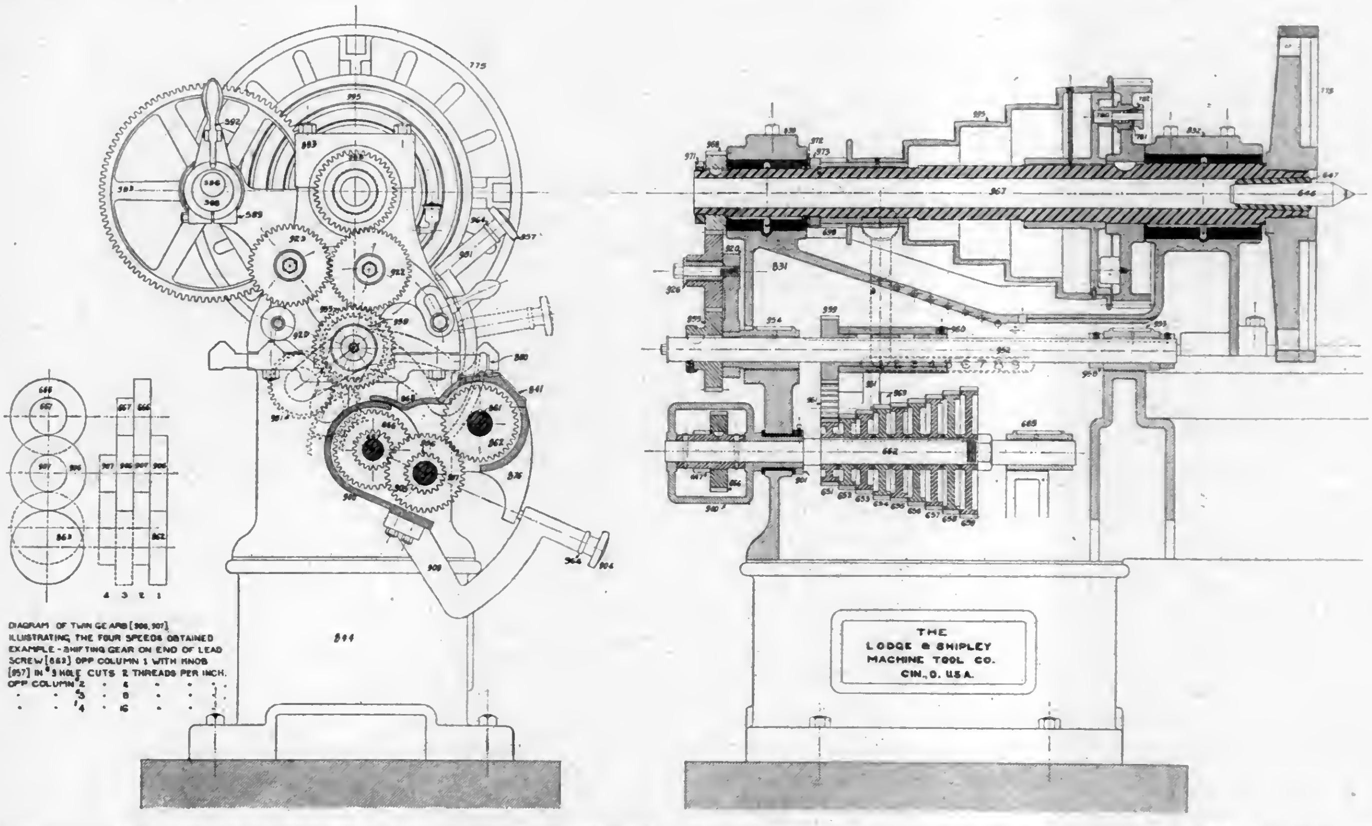


FIG. 51.—DETAILS OF THE POSITIVE GEARED FEEDING MECHANISMS WHICH ARE USED ON THE LATHES OF THE LODGE & SHIPLEY MACHINE TOOL COMPANY.

When properly in mesh with a gear of the cone the spring pin of the knob will lock into one of the numbered locking holes on the front side of the headstock; in changing speed it is merely necessary to shift the pinion by moving the knob along, when in its lowest position, until in line with the numbered hole desired, and then raise the knob until the locking pin springs into place.

The principle of the four-speed box, outside is also made clear in the accompanying engravings, although particularly so in the end elevation view in Fig. 51. The same general principle governs the operation of this mechanism as the other. Here four gears arranged upon a tumbler, or rocker arm, are driven at different speeds, and may be brought up into mesh, any one in turn, with a gear on the lead screw shaft. A similar method of locating and locking the tumbler knob is used, which provides great facility in operating the two devices.

The operation of the two mechanisms in combination for the entire range of screw threads, provided for is made easy by the use of a simple index plate, which shows in what positions to locate the knobs of the two mechanisms for obtaining them. The construction is simple, so that there is little liability of trouble and inaccuracies. The design is altogether commendable and tends toward serviceability.

A TEST OF FIREPROOF PAINT.

On October 17, 1903, the National Fire-Proof Paint Company completed another "public fire test" in the city of St. Louis with gratifying results. Two buildings were erected of the same material, 1-in. Georgia pine, and were erected

September 3, 1903, being 12 ft. high by 6 ft. square, and situated at the corner of LaClede and Vandevonter avenues.

One of the buildings was painted with two coats of the National Fire Proof Paint and the other one with a high grade brand of paint, purchased on the market in St. Louis. The test was made by placing a large quantity of combustible material, composed of hay and wood (over which was poured a quantity of kerosene) between the two buildings, which were situated with 5 ft. of space between.

An exceedingly high wind prevailed, and after starting the fire at 4 o'clock, it was at once noticed that the buildings painted with Fire Proof Paint was at a great disadvantage, as the wind forced the fire away from the other building and against the one painted with this paint, making the test an unusually severe one.

The fire soon became so intense that, notwithstanding the strong wind, both buildings received a baptism of fire, and the effect became noticed in less than ten minutes after the match was applied. Owing to the great mass of the fire being blown against the fire-proof painted building, and being retarded in its efforts to destroy the wood on which the fire-proof paint was applied, it became necessary to replenish with more fuel several times, thus taking a much longer period of time to complete the test than it would otherwise have done. Seventy-one minutes after the fire was started it caused the destruction of the building painted with standard paint so that it fell over against the fire-proof painted building, which remained standing, with but one side and one end severely charred, where the fire had come in direct contact with the woodwork. A close examination, however, showed conclusively that the fire had not spread in any manner whatsoever where it had not come in direct application with the woodwork of the fire-proof painted building, bearing out the claims made by the company.

There were present World's Fair and underwriter officials who conceded in the stand taken by the company as to their claims. The test was made with the permission of the city officials; the buildings standing forty-four days after application of the paint, being a much shorter time than that required to be thoroughly effective in retarding successfully the spread of fire on woodwork.

NATIONAL MACHINE TOOL BUILDER'S CONVENTION.

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A NEW STEAM TURBINE POWER PLANT.

NEW RAILROAD SHOPS AT AGUAS CALIENTES.

MEXICAN CENTRAL RAILWAY.

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The plant is the consolidation of, and is intended to replace, a number of smaller shops which were scattered along the lines of the system, the idea being to secure far better facilities and greater capacity and economy by concentrating the various shops in one, and at the same time to make a most complete and modern plant capable of handling all characters of railway repair and construction work, particularly in view of the remoteness of the large manufacturing and supply centers. A large installation was decided upon, including 20 new buildings and new equipment throughout, covering a tract of ground three-quarters of a mile long, and embracing 120 acres.

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In the design of this plant, special consideration was given to the adaptability, simplicity and economy of the various parts. The location of the plant being remote from the shops and manufacturers of the various apparatus, the feature of necessary repairs was worthy of important consideration, and every part of the complete plant was thoroughly considered and carefully planned.

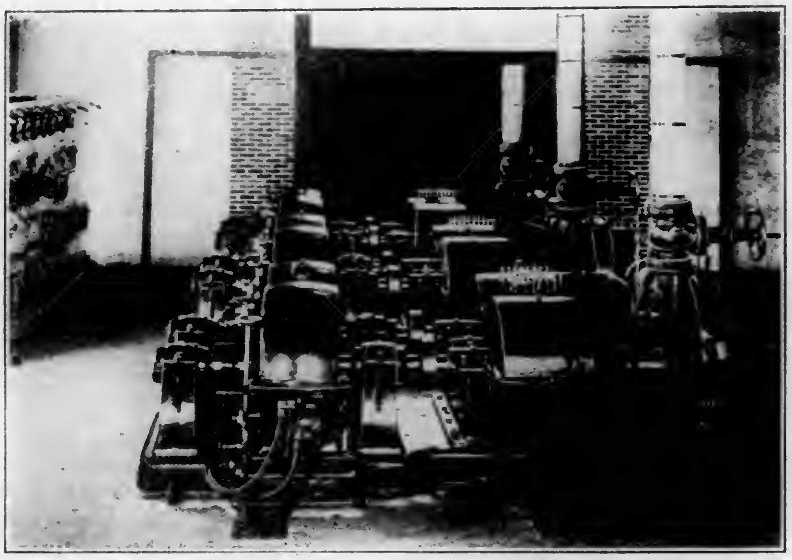
The use of individual power plants located in the various buildings was not considered, as from the standpoint of even the coal consumption alone, the increased economy of one central station over a number of smaller plants prohibited the division of the power plant. The electrical system of power transmission was the only one that could be used, and it was merely a matter of determining the best system suitable for the purpose.

The main yard being approximately three-quarters of a mile in length, with a smaller yard beyond, the transmission of power was a question of considerable importance. The use of a multi-phase alternating current system naturally suggested

itself, but for various reasons, it seemed inadvisable to install such a system; primarily because of the fact that it was desirable to operate certain apparatus with variable speed motors, particularly a number of large cranes, and for this service direct current is far superior to alternating current.

The extended area covered by the various buildings made it uneconomical to carry 250 volts, which is commonly used for power work in installations covering a smaller area, and it was finally determined to operate on the three wire system using 500 volts and 250 volts, thus securing the economy of 500 volts in transmission with the advantages of 250 volts for lighting and other purposes, the two voltages affording a simple and effective means of varying the speed of certain motors for use on wheel lathes and other machine tools.

The high price of fuel at this point made it of vital importance that the power generating equipment should be of the highest economy, and it was also necessary that it should be installed conformative with the most modern practice, as the consideration of the hardiness of the various parts of the apparatus and its ability to give continual service without the necessity of repairs was of equal, if not greater, importance in the power plant than in the balance of the installation. Steam turbine generators were considered to be best suited to meet



VIEW IN GENERATING ROOM, SHOWING ARRANGEMENT OF THE DE LAVAL STEAM TURBINES AND DIRECT-CONNECTED DYNAMOS.

VIEW IN THE BOILER ROOM, SHOWING CONCRETE PIER CONSTRUCTION.—BABCOCK & WILCOX BOILERS.

STEAM TURBINE POWER PLANT.—MEXICAN CENTRAL RAILWAY.

these requirements because of their simplicity and freedom from liability to break down, combined with their high economy of operation, and a thorough investigation of the subject led to the adoption of the De Laval combined steam turbine generator, built by the De Laval Steam Turbine Company.

It was decided to use water tube boilers designed to deliver 200 lbs. steam pressure with 100 to 120 degrees superheat, as the high pressure and the use of the superheat, will serve to increase the economy of the plant. Three Babcock & Wilcox water tube boilers are installed in the boiler house two in a battery and one in a half battery, each boiler being rated at 250 h.p., and capable of delivering 200 lbs. pressure with 120° superheat. Mechanical draft is used, being furnished by two Sturtevant fans, and a low stack is used, as shown in the external view of the power house.

In the generating room, three 300-h.p. De Laval steam turbines are installed, each direct-connected to 200-kw. double dynamos. The turbines are designed to operate condensing with 28 in. vacuum under the above-mentioned steam pressure. A general view of the arrangement of the turbines in the generating room is shown in an accompanying engraving. The most noticeable feature of the plant is the extreme compactness of arrangement of equipment, the entire turbo-generator equipment of 900-h.p. capacity, occupying no more space than a single 500-h.p. horizontal Corliss engine would.

The condenser is of the surface type; it is equipped with an automatic hot well pump, as well as a separate rotative dry vacuum pump, and a cooling tower is used to cool the circulating water. When operating at full load, a vacuum within 3 in. of the barometer is secured with a corresponding higher vacuum at higher loads.

Two steam driven air compressors complete the equipment of the plant for furnishing compressed air for operating the pneumatic tools and for the various other uses. The generating room is covered by a 10-ton traveling hand crane. All steam, water and air pipes and electrical conductors are placed in specially conducted ducts in the floor, covered with cast iron plates. The condenser pit is bridged with the necessary passage, which is flush with the floor.

The dynamos are of the well known De Laval double-armature type, direct-connected to the reduction gears of their turbines. They are wound for two voltages, 250 and 500 volts, the distribution system used being the 3-wire system. The switchboard is built up of blue Vermont marble and contains a full equipment of Weston instruments and all necessary switches and circuit breakers, as well as a recording wattmeter which measures the total power generated in the station.

The various shop buildings and stores are thoroughly equipped with elevators and with stationary and portable platform scales and cranes. In the erecting shop, two 60-ton 3-motor cranes travel the main span, while the two bays at each side are equipped with single motor cranes of 5-tons capacity. In order to minimize the stock of wearing and repair parts for motors, the least possible number in horsepower sizes was selected. For this reason, and on account of the fact that a large number of machine tools were to be installed, the group system of drive was generally adopted, although a number of new machine tools have been installed with the most approved method of individual motor driving.

The power is transmitted throughout the yards on overhead lines carried on iron poles in a substantial and thorough manner, all poles being set in concrete and uniformly painted. All mains are carried to the centres of distribution located inside the buildings, where complete equipments of switches and fuses are provided, and the lines leading from the centres to the individual motors are carried in steel conduit, in most instances under the floor. The motors are all protected by circuit breakers for the larger sizes and by suitable fuses for the smaller units.

The entire equipment was installed by the D'Olier Engineering Company, Philadelphia, Pa., sales agents for the De Laval steam turbines, to whom we are much indebted for this interesting information.

September 3, 1903, being 12 ft. high by 6 ft. square, and situated at the corner of LaClede and Vandevonter avenues.

One of the buildings was painted with two coats of the National Fire Proof Paint and the other one with a high grade brand of paint, purchased on the market in St. Louis. The test was made by placing a large quantity of combustible material, composed of hay and wood (over which was poured a quantity of kerosene) between the two buildings, which were situated with 5 ft. of space between.

An exceedingly high wind prevailed, and after starting the fire at 4 o'clock, it was at once noticed that the buildings painted with Fire Proof Paint was at a great disadvantage, as the wind forced the fire away from the other building and against the one painted with this paint, making the test an unusually severe one.

The fire soon became so intense that, notwithstanding the strong wind, both buildings received a baptism of fire, and the effect became noticed in less than ten minutes after the match was applied. Owing to the great mass of the fire being blown against the fire-proof painted building, and being retarded in its efforts to destroy the wood on which the fire-proof paint was applied, it became necessary to replenish with more fuel several times, thus taking a much longer period of time to complete the test than it would otherwise have done. Seventy-one minutes after the fire was started it caused the destruction of the building painted with standard paint so that it fell over against the fire-proof painted building, which remained standing, with but one side and one end severely charred, where the fire had come in direct contact with the woodwork. A close examination, however, showed conclusively that the fire had not spread in any manner whatsoever where it had not come in direct application with the woodwork of the fire-proof painted building, bearing out the claims made by the company.

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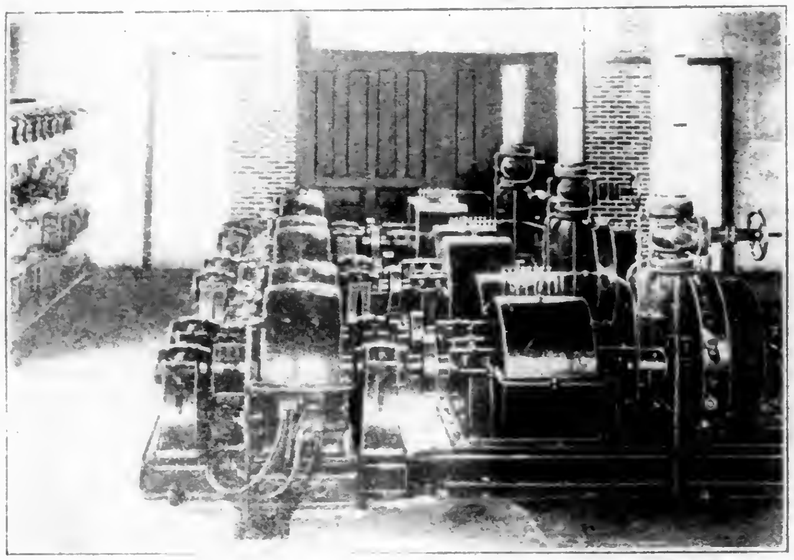
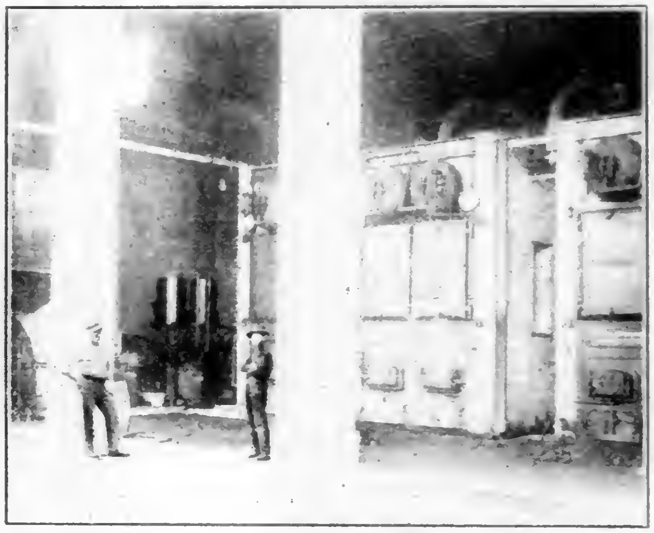


VIEW IN GENERATING ROOM, SHOWING ARRANGEMENT OF THE DE LAVAL STEAM TURBINES AND DIRECT-CONNECTED DYNAMOS.



VIEW IN THE BOILER ROOM, SHOWING CONCRETE PIER CONSTRUCTION — BABCOCK & WILCOX BOILERS.

STEAM TURBINE POWER PLANT.—MEXICAN CENTRAL RAILWAY.

BOOKS AND PAMPHLETS.

Fowler's Mechanical Engineer's Pocket Book, 1904. Edited by William H. Fowler. Published by The Scientific Publishing Company, Manchester, England. Price in leatherette 1 shilling 9 pence, in leather 2 shillings 9 pence.

This pocket book of tables and data is becoming more valuable every year. Not the least important feature is the fact that by annual revision it may be kept up to date and even with the ever-changing requirements for engineering information. In view of the low price of the book the reviewer is disarmed as to most of the criticisms of the work. It is certainly well worth the price, and much more. The complete revision of the treatment of gas engines under the direction of Mr. James Dunlop is one of the special features of this edition.

Proceedings of the Thirty-seventh Annual Convention of the Master Car Builders' Association, held at Saratoga in 1903. Chicago (The Rookery): J. W. Taylor, Secretary.

This year the records of this association require a volume of 620 pages, the largest in its history. Besides the rules, lists of officers and members, the volume contains the papers and reports of the convention of last summer, the discussions thereon, the complete record of standards and recommended practice, and an index. The result of the letter ballot on the changes in the interchange rules is also included. The ability of the secretary of the association is indicated in the appearance of this volume only four months after the close of the convention.

POOR'S MANUAL OF RAILROADS FOR 1903.—The advance sheets of the introduction to the thirty-sixth annual issue of this invaluable publication are before us. They contain the usual statistical summaries of the finacial affairs and operations of the railroads and give comparisons of statistics reaching in some of the tables as early as 1830. The figures of track mileage and rolling equipment are compared for each year from 1880, and in nearly all cases the tables present the figures for the last three years. The total length of railroads completed on December 31, 1902, was 203,131.61 miles, the net increase of mileage reported in the fiscal year 1902 being 3,246.95 miles. Sixteen pages of tables are presented in this summary. This year the volume will contain 180 additional pages, and while the book is somewhat delayed because of being set by machine, advantage has been taken of this fact to include the latest information secured.

Commutator Construction. By Wm. Baxter, Jr. 23 pages, 6 x 9 ins., in pamphlet form. The third of a series of practical papers, each complete in itself. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 25 cents.

The importance of thoroughly understanding the design and construction of commutators for electric dynamos and motors is best appreciated by those who have this class of apparatus to care for; it is safe to say that none can properly care for commutators without understanding their construction. This work will meet a long felt want in placing upon the market a comprehensive and easily understood discussion of this subject, to assist those having charge of dynamos and motors. The treatment is plain and complete, and the illustrations are numerous and clear. An important part is the chapter at the end devoted to repairing commutators, in which detailed instructions and good advice is given.

Up-to-Date Air Brake Catechism. By Robert H. Blackall, Air Brake Instructor and Inspector with Westinghouse Air Brake Company. Eighteenth Edition. Published by Norman W. Henley & Co., 132 Nassau Street, New York, 1903. Price, $2.

The fact that this book has reached eighteen editions since its first appearance, in 1898, speaks for its reception and indicates that it fills a need. It has been completely revised and enlarged. The present edition is accompanied by two large colored charts of the Westinghouse passenger and locomotive equipments. These indicate by the colored portions the various functions of the apparatus, and are well executed. With this book available, no one who desires to understand the air brake need make excuses for not doing so. It is profusely illustrated, and gives evidence at every page of the manner of its development, which is exactly the way one who knows would thoroughly explain the air brake to those who are using it and those who are learning to do so. The explanations are carried even to the operation of trains, and include inspections and tests. The book justifies the title, and is a very valuable work by one who understands his subject so well as to be able to foresee and provide for the difficulties which are before the student. It may be said without the slightest hesitation that one who has mastered this book is thoroughly "up" on air brakes, and that every railroad officer, as well as those who actually use the apparatus, should study it. The price mentioned, $2, includes the charts, the price of the charts alone being $1.

Coal, Cinders and Freight. Book No. 36. Issued by the "Link Belt" Companies. Devoted to Modern Methods applied to the Coaling of Locomotives, Disposing of Cinders, and Handling of Freight in Depots, Warehouses, etc. 96 pages, 9 x 12; cloth, profusely and beautifully illustrated. Published by the Link-Belt Engineering Company, Philadelphia, Pa.

This is a most valuable and interesting treatise of the subjects of mechanical handling of coal, ashes and freight, by the most modern methods, undoubtedly eclipsing all efforts previously made in this line. The illustrations are most excellent and clear, and nearly half of them are full-page photogravures in color. The large number of coal and ash handling plants that these companies have installed upon our leading railroads are carefully illustrated and discussed in a most interesting manner. It is a revelation to observe the methods employed for large plants for stocking and reloading coal, as well as also in power plant installations for handling coal and ashes. Many different systems are illustrated and described for handling all classes of package and bulk freight for depots, warehouses, etc. This is one of the most valuable works of the kind that has been issued and should be in the hands of all who are interested in the subject of mechanical handling of coal, cinders, freight, etc.

GRAPHITE LUBRICANTS is the title of a 20-page pamphlet issued by the Joseph Dixon Crucible Company, of Jersey City, N. J., which is devoted to an explanation of graphite as a lubricant. The chapter entitled "How Graphite Lubricates" is well worth reading.

THE AMERICAN BLOWER COMPANY, of Detroit, have issued five attractive pamphlets, illustrating and describing their apparatus. They are Mechanical Draft Catalog, No. 118, Second Edition; Heating and Ventilating of Manufacturing Establishments, No. 145, Second Edition; Steel Plate Fan Catalog, No. 155 and Circulars, Nos. 39 and 42. Each is complete in itself and collectively, they present an excellent idea of the state of the art as practiced by these manufacturers. Readers who have to do with any of these subjects will do well to secure the pamphlets.

THE AMERICAN TOOL WORKS COMPANY, CINCINNATI, OHIO, have recently issued a neat little reminder, in the form of a small illustrated pamphlet, to call attention to the large assortment of machine tools which they are building. New designs have recently been completed for all the lines of tools manufactured to bring them up-to-date and make them capable of handling the heaviest work that will be imposed by the new heavy duty tool steels. This little pamphlet is well worth examination, presenting, as it does, one of the most complete and excellent lines of machine tools that are built. It will be gladly sent to anyone upon request.

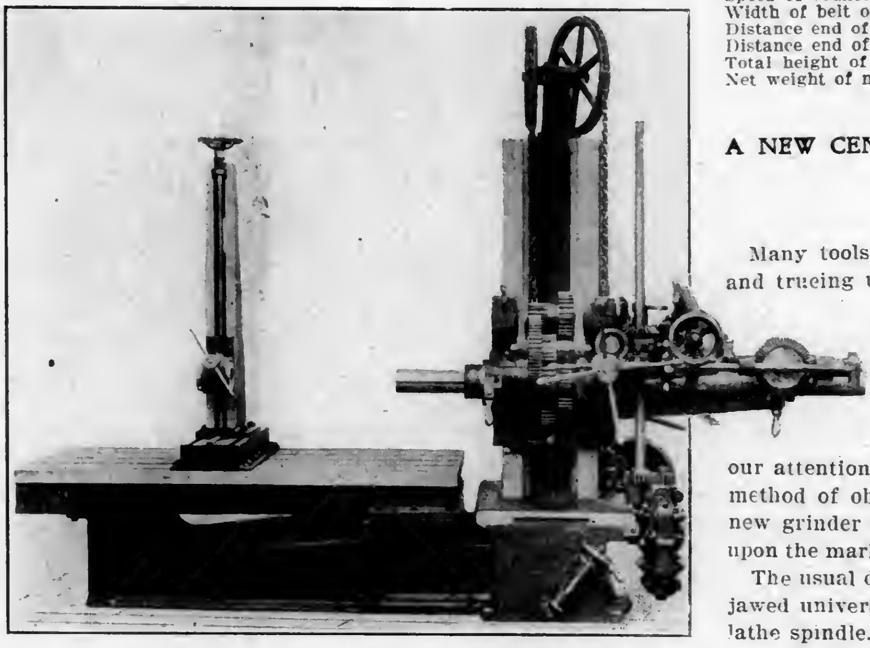
RADIAL EFFICIENCY is the title of an interesting new booklet that Prentice Bros. Company, Worcester, Mass., have recently gotten out, descriptive of the new designs of their radial drilling machines. The Prentice Company have recently entirely redesigned their line of radial drills, improving and strengthening to meet the demands of modern machine shop service, and they have added the very desirable feature of the positive-geared driving mechanism, so essential in drilling work. The efficiency of the new radial is discussed in the booklet in an interesting and convincing manner, and the capacity is a surprise. The Prentice Company indicate also that they have met the demands of the times by arranging their radials for easy application of motor driving—an important feature in modern shop practice. Every shop man should have this pamphlet.

PASSENGER COUPLERS.—A pamphlet has been received from the Washburn Company, Minneapolis, Minn., illustrating and describing the passenger couplers of their manufacture. These makers have a long record behind them and have not rushed into the market with untried devices. These couplers are the result of long study of the requirements of passenger service. Everyone knows the annoyance of delays due to failures of passenger couplers to couple, for example when a flyer is laid out in order to couple to a dining car on a curved siding. To meet this difficulty the flexible head coupler has been developed. It also meets the problem of a satisfactory coupler between tenders and passenger equipment cars with long overhang. This company makes spring buffers and spring coupler carriers in a series of devices, making with the Washburn coupler, a complete coupler equipment for passenger and freight cars. The pamphlet is an excellent example of catalog literature.

A NEW HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

Fosdick Machine Tool Company.

A new departure in the line of drilling machinery has recently been made by the Fosdick Machine Tool Company, Cincinnati, Ohio, in placing upon the market a new drilling machine of the horizontal type, which is coming into such general use for large numbers of complicated machining operations. The new Fosdick horizontal drill embodies many new features of importance which will render it universally adaptable for operations of boring, drilling, tapping, reaming, facing, milling, etc., on both light and heavy work, in the most economical manner possible, all of the above mentioned operations being possible in one setting of a piece of work fastened to the table, insuring the most accurate and profitable results. The half tone engraving presented herewith was made from a photograph of the machine and shows its well proportioned design.



THE NEW FOSDICK HORIZONTAL DRILLING MACHINE.

The drive for the machine is made through a splined shaft, traversing the driving cone on the rear of bed, and leading to the gearing at the base of the column. The column which carries the spindle head, has a horizontal movement on the bed by hand or power in both directions, and is supplemented by a quick forward and return motion by power, operated by the hand-wheel conveniently located on the front of bed.

The spindle head has a vertical movement on the column by hand or power in both directions, being well counterbalanced and provided with a safety chain, and for quick adjustment is operated through a rack and pinion with ease by the pilot wheel on the front of the spindle head. The spindle runs in adjustable bronze bearings and has a thread cut on its projecting end to receive chucks, large milling cutters, facing heads, etc., for very heavy work. It can be made to revolve in either right or left hand directions by means of a reverse lever; this is very convenient for facing, tapping, milling and other operations.

The spindle bar, which passes through the hollow spindle, is 4 ins. in diameter, has 22 ins. traverse and is fitted with a No. 5 Morse taper to receive drills, taps, reamers, boring bars, milling cutters, etc. It has power and hand feed in both directions, may be operated from the pilot wheel for quick adjustment, and can be securely clamped for face milling purposes. For very heavy work the cutter, or boring bar, is secured by a cotter fitted to the spindle bar.

All the feeds, for horizontal traverse of column, and horizontal and vertical feeds of spindle head, are taken from the spindle; they are positive-geared and reversible, eight in number by hand or power, and are arranged in geometrical progression from .007 to ¼ in. per revolution of the spindle. The spindle speeds are ten in number, arranged in geometrical progression from 4 to 260 rev. per min. The gear ratio from the cone-driving shaft to spindle is 2 2-3 to 1. and the ratio of back gears is 13.6 to 1.

SPECIFICATIONS.

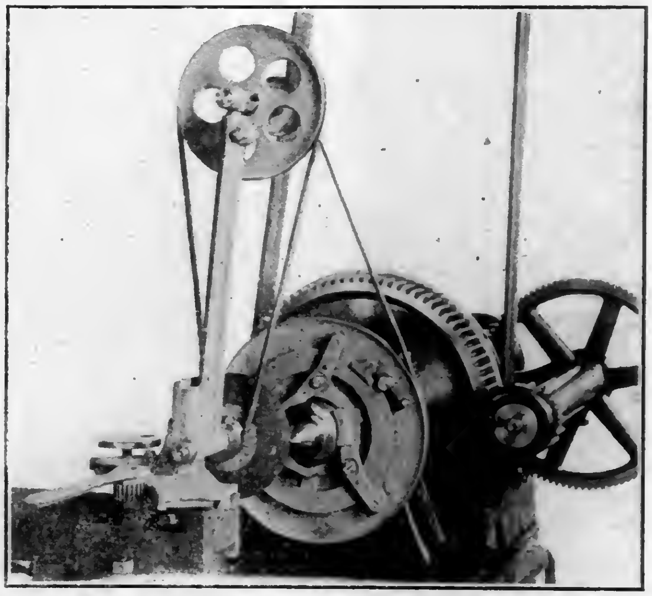
Diameter of spindle bar	4 ins.
Diameter of spindle nose	6 ins.
Traverse of spindle	22 ins.
Vertical adjustment of head on column	36 ins.
Horizontal adjustment of column on bed	32 ins.
Maximum distance table to center of spindle	44 ins.
Minimum distance table to center of spindle	7½ ins.
Size of table	31 x 72 ins.
Tight and loose pulley on countershaft	16 x 4 ins.
Speed of countershaft	228 rev. per min.
Width of belt on cone	3½ ins.
Distance end of pulley shaft to end of bed	9 ft. 9 ins.
Distance end of spindle to end of table	12 ft. 6 ins.
Total height of machine	8 ft.
Net weight of machine	12,000 lbs.

A NEW CENTER GRINDER OF INTERESTING DESIGN.

Mueller Machine Tool Co.

Many tools have been devised for the purpose of grinding and trueing up centers for lathes, and various degrees of ingenuity have been displayed in their designs. The difficulty has been in the method of driving the grinding wheel in most cases, with the exception, of course, of the more expensive motor-driven types. But no device of this type of a mechanical nature has been brought to our attention, which involves a more ingenious, yet practical, method of obtaining the drive for the emery wheel than the new grinder illustrated herewith, which has just been placed upon the market by the Mueller Machine Tool Co., Cincinnati, O.

The usual difficulties have been avoided by the use of a three-jawed universal chuck pulley for obtaining the drive from the lathe spindle. It is merely clamped over the nose of the lathe spindle, the construction being such that the threads on the nose will not be marred thereby, and revolves with the spindle for driving the grinding mechanism.



NEW DESIGN OF CENTER GRINDER.—MUELLER MACHINE TOOL CO.

The grinding wheel spindle is carried in a bracket which is arranged to bolt on the lathe tool block as shown in the view of the device. The bracket has a vertical adjustment to permit bringing the grinding spindle to the level of the lathe center, and provision is made for accurately grinding centers to a 60-degree angle by a cross slide adjustment at the base of the bracket, operating at an angle of 30 degrees to the lathe spindle.

BOOKS AND PAMPHLETS.

Fowler's Mechanical Engineer's Pocket Book, 1904. Edited by William H. Fowler. Published by The Scientific Publishing Company, Manchester, England. Price in leatherette 1 shilling 9 pence, in leather 2 shillings 9 pence.

This pocket book of tables and data is becoming more valuable every year. Not the least important feature is the fact that by annual revision it may be kept up to date and even with the ever-changing requirements for engineering information. In view of the low price of the book the reviewer is disarmed as to most of the criticisms of the work. It is certainly well worth the price, and much more. The complete revision of the treatment of gas engines under the direction of Mr. James Dunlop is one of the special features of this edition.'

Proceedings of the Thirty-seventh Annual Convention of the Master Car Builders' Association, held at Saratoga in 1903. Chicago (The Rookery): J. W. Taylor, Secretary.

This year the records of this association require a volume of 620 pages, the largest in its history. Besides the rules, lists of officers and members, the volume contains the papers and reports of the convention of last summer, the discussions thereon, the complete record of standards and recommended practice, and an index. The result of the letter ballot on the changes in the interchange rules is also included. The ability of the secretary of the association is indicated in the appearance of this volume only four months after the close of the convention.

Poor's Manual of Railroads for 1903.—The advance sheets of the introduction to the thirty-sixth annual issue of this invaluable publication are before us. They contain the usual statistical summaries of the finacial affairs and operations of the railroads and give comparisons of statistics reaching in some of the tables as early as 1830. The figures of track mileage and rolling equipment are compared for each year from 1880, and in nearly all cases the tables present the figures for the last three years. The total length of railroads completed on December 31, 1902, was 203,131.61 miles, the net increase of mileage reported in the fiscal year 1902 being 3,246.95 miles. Sixteen pages of tables are presented in this summary. This year the volume will contain 180 additional pages, and while the book is somewhat delayed because of being set by machine, advantage has been taken of this fact to include the latest information secured.

Commutator Construction. By Wm. Baxter, Jr. 23 pages, 6 x 9 ins., in pamphlet form. The third of a series of practical papers, each complete in itself. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 25 cents.

The importance of thoroughly understanding the design and construction of commutators for electric dynamos and motors is best appreciated by those who have this class of apparatus to care for; it is safe to say that none can properly care for commutators without understanding their construction. This work will meet a long felt want in placing upon the market a comprehensive and easily understood discussion of this subject, to assist those having charge of dynamos and motors. The treatment is plain and complete, and the illustrations are numerous and clear. An important part is the chapter at the end devoted to repairing commutators, in which detailed instructions and good advice is given.

Up-to-Date Air Brake Catechism. By Robert H. Blackall, Air Brake Instructor and Inspector with Westinghouse Air Brake Company. Eighteenth Edition. Published by Norman W. Henley & Co., 132 Nassau Street, New York, 1903. Price, $2.

The fact that this book has reached eighteen editions since its first appearance, in 1898, speaks for its reception and indicates that it fills a need. It has been completely revised and enlarged. The present edition is accompanied by two large colored charts of the Westinghouse passenger and locomotive equipments. These indicate by the colored portions the various functions of the apparatus, and are well executed. With this book available, no one who desires to understand the air brake need make excuses for not doing so. It is profusely illustrated, and gives evidence at every page of the manner of its development, which is exactly the way one who knows would thoroughly explain the air brake to those who are using it and those who are learning to do so. The explanations are carried even to the operation of trains, and include inspections and tests. The book justifies the title, and is a very valuable work by one who understands his subject so well as to be able to foresee and provide for the difficulties which are before the student. It may be said without the slightest hesitation that one who has mastered this book is thoroughly "up" on air brakes, and that every railroad officer, as well as those who actually use the apparatus, should study it. The price mentioned, $2, includes the charts, the price of the charts alone being $1.

Coal, Cinders and Freight. Book No. 36. Issued by the "Link Belt" Companies. Devoted to Modern Methods applied to the Coaling of Locomotives, Disposing of Cinders, and Handling of Freight in Depots, Warehouses, etc. 96 pages, 9 x 12; cloth, profusely and beautifully illustrated. Published by the Link-Belt Engineering Company, Philadelphia, Pa.

This is a most valuable and interesting treatise of the subjects of mechanical handling of coal, ashes and freight, by the most modern methods, undoubtedly eclipsing all efforts previously made in this line. The illustrations are most excellent and clear, and nearly half of them are full-page photogravures in color. The large number of coal and ash handling plants that these companies have installed upon our leading railroads are carefully illustrated and discussed in a most interesting manner. It is a revelation to observe the methods employed for large plants for stocking and reloading coal, as well as also in power plant installations for handling coal and ashes. Many different systems are illustrated and described for handling all classes of package and bulk freight for depots, warehouses, etc. This is one of the most valuable works of the kind that has been issued and should be in the hands of all who are interested in the subject of mechanical handling of coal, cinders, freight, etc.

Graphite Lubricants is the title of a 20-page pamphlet issued by the Joseph Dixon Crucible Company, of Jersey City, N. J., which is devoted to an explanation of graphite as a lubricant. The chapter entitled "How Graphite Lubricates" is well worth reading.

The American Blower Company, of Detroit, have issued five attractive pamphlets, illustrating and describing their apparatus. They are Mechanical Draft Catalog, No. 118, Second Edition; Heating and Ventilating of Manufacturing Establishments, No. 145, Second Edition; Steel Plate Fan Catalog, No. 155 and Circulars, Nos. 39 and 42. Each is complete in itself and collectively, they present an excellent idea of the state of the art as practiced by these manufacturers. Readers who have to do with any of these subjects will do well to secure the pamphlets.

The American Tool Works Company, Cincinnati, Ohio, have recently issued a neat little reminder, in the form of a small illustrated pamphlet, to call attention to the large assortment of machine tools which they are building. New designs have recently been completed for all the lines of tools manufactured to bring them up-to-date and make them capable of handling the heaviest work that will be imposed by the new heavy duty tool steels. This little pamphlet is well worth examination, presenting, as it does, one of the most complete and excellent lines of machine tools that are built. It will be gladly sent to anyone upon request.

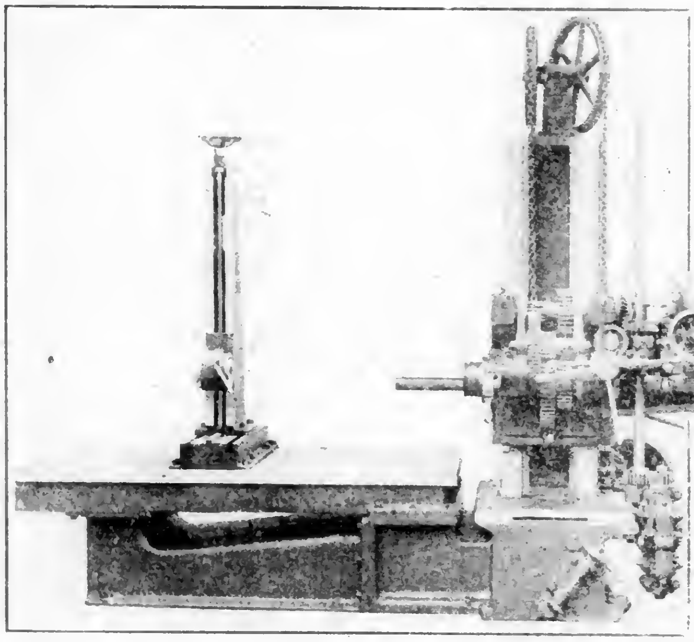
Radial Efficiency is the title of an interesting new booklet that Prentice Bros. Company, Worcester, Mass., have recently gotten out, descriptive of the new designs of their radial drilling machines. The Prentice Company have recently entirely redesigned their line of radial drills, improving and strengthening to meet the demands of modern machine shop service, and they have added the very desirable feature of the positive-geared driving mechanism, so essential in drilling work. The efficiency of the new radial is discussed in the booklet in an interesting and convincing manner, and the capacity is a surprise. The Prentice Company indicate also that they have met the demands of the times by arranging their radials for easy application of motor driving—an important feature in modern shop practice. Every shop man should have this pamphlet.

Passenger Couplers.—A pamphlet has been received from the Washburn Company, Minneapolis, Minn., illustrating and describing the passenger couplers of their manufacture. These makers have a long record behind them and have not rushed into the market with untried devices. These couplers are the result of long study of the requirements of passenger service. Everyone knows the annoyance of delays due to failures of passenger couplers to couple, for example when a flyer is laid out in order to couple to a dining car on a curved siding. To meet this difficulty the flexible head coupler has been developed. It also meets the problem of a satisfactory coupler between tenders and passenger equipment cars with long overhang. This company makes spring buffers and spring coupler carriers in a series of devices, making with the Washburn coupler, a complete coupler equipment for passenger and freight cars. The pamphlet is an excellent example of catalog literature.

A NEW HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

FOSDICK MACHINE TOOL COMPANY

A new departure in the line of drilling machinery has recently been made by the Fosdick Machine Tool Company, Cincinnati, Ohio, in placing upon the market a new drilling machine of the horizontal type, which is coming into such general use for large numbers of complicated machining operations. The new Fosdick horizontal drill embodies many new features of importance which will render it universally adaptable for operations of boring, drilling, tapping, reaming, facing, milling, etc., on both light and heavy work, in the most economical manner possible, all of the above mentioned operations being possible in one setting of a piece of work fastened to the table, insuring the most accurate and profitable results. The half tone engraving presented herewith was made from a photograph of the machine and shows its well proportioned design.



THE NEW FOSDICK HORIZONTAL DRILLING MACHINE.

The drive for the machine is made through a splined shaft, traversing the driving cone on the rear of bed, and leading to the gearing at the base of the column. The column which carries the spindle head, has a horizontal movement on the bed by hand or power in both directions, and is supplemented by a quick forward and return motion by power, operated by the hand-wheel conveniently located on the front of bed.

The spindle head has a vertical movement on the column by hand or power in both directions, being well counterbalanced and provided with a safety chain, and for quick adjustment is operated through a rack and pinion with ease by the pilot wheel on the front of the spindle head. The spindle runs in adjustable bronze bearings and has a thread cut on its projecting end to receive chucks, large milling cutters, facing heads, etc., for very heavy work. It can be made to revolve in either right or left hand directions by means of a reverse lever; this is very convenient for facing, tapping, milling and other operations.

The spindle bar, which passes through the hollow spindle, is 4 ins. in diameter, has 22 ins. traverse and is fitted with a No. 5 Morse taper to receive drills, taps, reamers, boring bars milling cutters, etc. It has power and hand feed in both directions, may be operated from the pilot wheel for quick adjustment, and can be securely clamped for face milling purposes For very heavy work the cutter, or boring bar, is secured by a cotter fitted to the spindle bar.

All the feeds, for horizontal traverse of column, and horizontal and vertical feeds of spindle head, are taken from the spindle; they are positive-geared and reversible, eight in number by hand or power, and are arranged in geometrical progression from .007 to ¼ in. per revolution of the spindle. The spindle speeds are ten in number, arranged in geometrical progression from 4 to 260 rev. per min. The gear ratio from the cone-driving shaft to spindle is 2 2-3 to 1, and the ratio of back gears is 13.6 to 1.

SPECIFICATIONS.

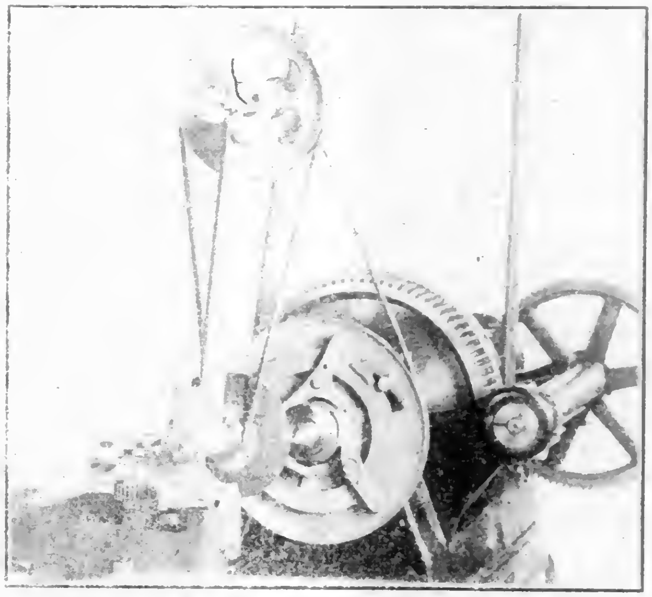
Diameter of spindle bar	4 ins.
Diameter of spindle nose	6 ins.
Traverse of spindle	22 ins.
Vertical adjustment of head on column	36 ins.
Horizontal adjustment of column on bed	32 ins.
Maximum distance table to center of spindle	44 ins.
Minimum distance table to center of spindle	7½ ins.
Size of table	31 x 72 ins.
Tight and loose pulley on countershaft	16 x 4 ins.
Speed of countershaft	228 rev. per min.
Width of belt on cone	3½ ins.
Distance end of pulley shaft to end of bed	9 ft. 9 ins.
Distance end of spindle to end of table	12 ft. 6 ins.
Total height of machine	8 ft.
Net weight of machine	12,000 lbs.

A NEW CENTER GRINDER OF INTERESTING DESIGN.

MUELLER MACHINE TOOL CO.

Many tools have been devised for the purpose of grinding and trueing up centers for lathes, and various degrees of ingenuity have been displayed in their designs. The difficulty has been in the method of driving the grinding wheel in most cases, with the exception, of course, of the more expensive motor-driven types. But no device of this type of a mechanical nature has been brought to our attention, which involves a more ingenious, yet practical, method of obtaining the drive for the emery wheel than the new grinder illustrated herewith, which has just been placed upon the market by the Mueller Machine Tool Co., Cincinnati, O.

The usual difficulties have been avoided by the use of a three-jawed universal chuck pulley for obtaining the drive from the lathe spindle. It is merely clamped over the nose of the lathe spindle, the construction being such that the threads on the nose will not be marred thereby, and revolves with the spindle for driving the grinding mechanism.



NEW DESIGN OF CENTER GRINDER.—MUELLER MACHINE TOOL CO.

The grinding wheel spindle is carried in a bracket which is arranged to bolt on the lathe tool block as shown in the view of the device. The bracket has a vertical adjustment to permit bringing the grinding spindle to the level of the lathe center, and provision is made for accurately grinding centers to a 60-degree angle by a cross slide adjustment at the base of the bracket, operating at an angle of 30 degrees to the lathe spindle.

The latter cross slide adjustment is clearly shown in the engraving; it is operated by the handle shown carrying a pinion which meshes with a rack cut on the edge of the cross slide.

In mounting the mechanism, it is clamped in the tool block with a shoulder on the bracket base snug against one side of the tool block which brings the cross slide on a line exactly 30 degrees from the lathe spindle center. Then the endless belts are slipped on their pulleys, and the tool is ready for use; this entire operation requires but a few moments.

The spindle that carries the emery wheel is ground taper, having provision for taking up wear, and also has a dust cap for protection from grit. The speed ratio from the chuck-driving pulley to the grinder spindle is such that the grinding wheel will make 1,600 rev. per min., when the lathe spindle speed is 250 rev. per min. An important feature of this tool is the fact that any twisting of belts is rendered entirely unnecessary.

This tool is also applicable to other kinds of light circular grinding by placing a driving drum overhead the lathe, for which many uses may be found for it. It also is provided with a small rest, as shown at the left of the emery wheel, which is particularly convenient for sharpening cutters, drills and light work.

A NEW LOCOMOTIVE FRAME DRILL.

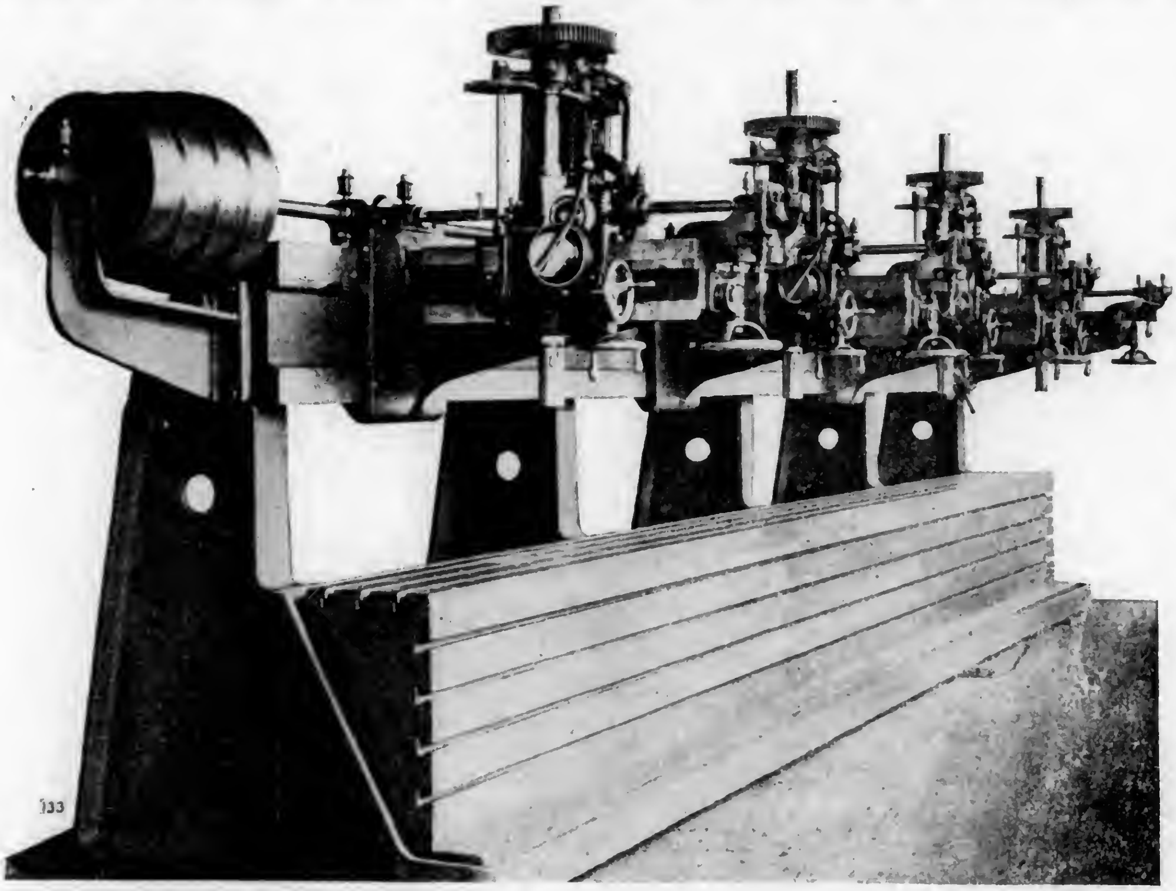
BICKFORD DRILL AND TOOL COMPANY.

The multiple-spindle drill illustrated in the accompanying engraving is an interesting new design of drilling machine that has recently been developed especially for use in drilling locomotive frames. It departs from the usual practice in this class of machinery in several features which tend to facilitate operations upon the tool and add convenience to its manipulation. It was designed and built by The Bickford Drill and Tool Company, Cincinnati, Ohio, from specifications submitted by the Locomotive and Machine Company, Montreal, Canada, and is to be used at the new shops of the latter company for drilling, reaming and tapping the sides and edges of locomotive frames of sizes up to 27 ft. 3 ins. between holes.

The tool is built with four projecting arms, arranged upon a cross rail, of stiff construction and well supported. The arm at the right-hand end is arranged to rotate through an angle of 30 degrees. The arms are made in pipe section, the usual Bickford construction, and are adjustable on the rail either by hand or power.

The spindles have eight changes of speed, ranging in geometrical progression from 49 to 120 revolutions per minute, and are provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gauge, and hand lever reverse. The back gears are located on the head, bringing the power direct to the work, and may be engaged, disengaged, or thrown out of service while the machine is running, and the operator is not obliged to reach the shifter in order to stop the spindle.

The depth gauge answers a double purpose in this application; besides enabling the operator to read all depths from zero (which does away with the usual delays concomitant to scaling or calipering), it also supplies a convenient means for setting the automatic trip, the graduations showing exactly where each dog should be set in order to disengage the feed at the desired points.



FOUR-SPINDLE LOCOMOTIVE FRAME DRILL OF NEW DESIGN.—BICKFORD DRILL AND TOOL COMPANY.

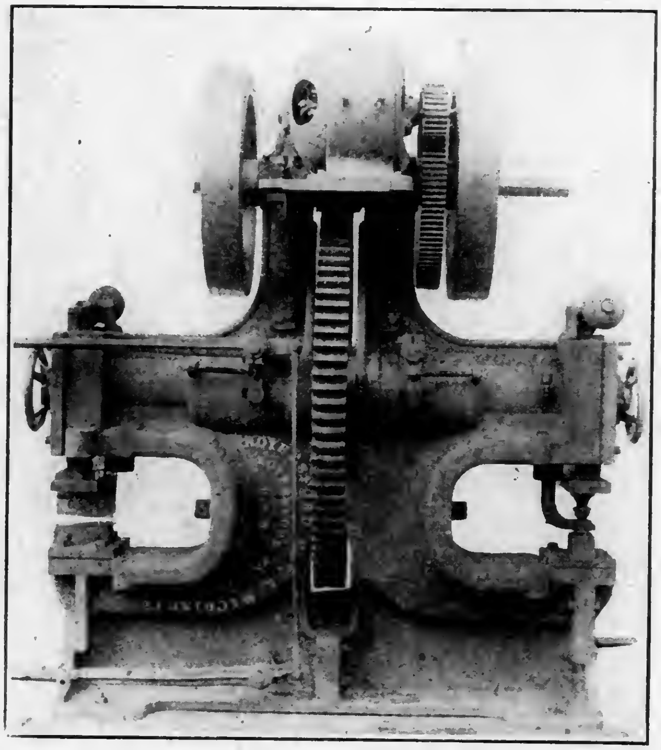
The feeding mechanism furnishes eight rates of feed, ranging in geometrical progression from .007 in. to .064 in. per revolution of spindle, each of which is instantly available, eliminating all loss of time incident to shifting a belt. An engraved plate attached to the head shows the operator how to obtain each of the feeds. The tapping mechanisms are located on the heads, and are fitted with friction clutches operated by levers the handles of which extend around under the arms within convenient reach of the operator.

The spindles are 2¼ ins. in diameter, have a vertical adjustment of 17 ins., and operate over an area of 2 ft. 4 ins. x 27 ft. 3 ins. The table has a width of 18 ins., a height of 30 ins. and a length of 29 ft. The machine weighes 49,000 lbs., and is designed to be driven by a 5-in. high speed double belt.

A MODERN DESIGN OF ELECTRICALLY DRIVEN COMBINED PUNCH AND SHEAR.

Royersford Foundry and Machine Co.

The tool illustrated in the accompanying engraving is an interesting application of motor driving to the requirements of modern punching and shearing machinery service. The design of this machine is extremely heavy, and in the effort used



THE ROYERSFORD MOTOR-DRIVEN COMBINED PUNCH AND SHEAR

to bring the construction up to modern requirements, the ordinary standards have been greatly surpassed in this design.

Exceptional fly-wheel capacity has been provided to store up a large surplus of energy between strokes for driving at instants of punching or shearing. It will be noticed that the fly-wheels are located close together, and as the shaft is very short, and also of large diameter, there is little chance for torsion or spring in the shaft. This is an important feature in connection with a punch or shearing machine.

The drive is furnished by a 5 h.p. constant-speed direct-current motor, built by the Crocker-Wheeler Company, Ampere, N. J., which drives the cast steel gear on the fly-wheel shaft through a rawhide pinion on the armature shaft. The gear ratios are such as to bring the proper fly-wheel speed, for which the machine was designed, directly. This style of drive is very convenient and neat, requiring no extra floor space and also keeping the motor up out of the way of harm.

This machine has an 18-in. throat on both sides, and has a shearing capacity of 6 ins. x ¾ in. flat and 1¼ ins. round iron and a punching capacity of 1-in. hole through ⅝-in. iron plate. It will also be noticed that the punch side is provided with a removable lower jaw, which makes it desirable for punching I-beams and channels. This makes an ideal machine for punch and shear work of modern requirements. The eccentric shaft is of steel and of a large diameter, giving ample wearing surface. The eccentric boxes are made of phosphorus bronze.

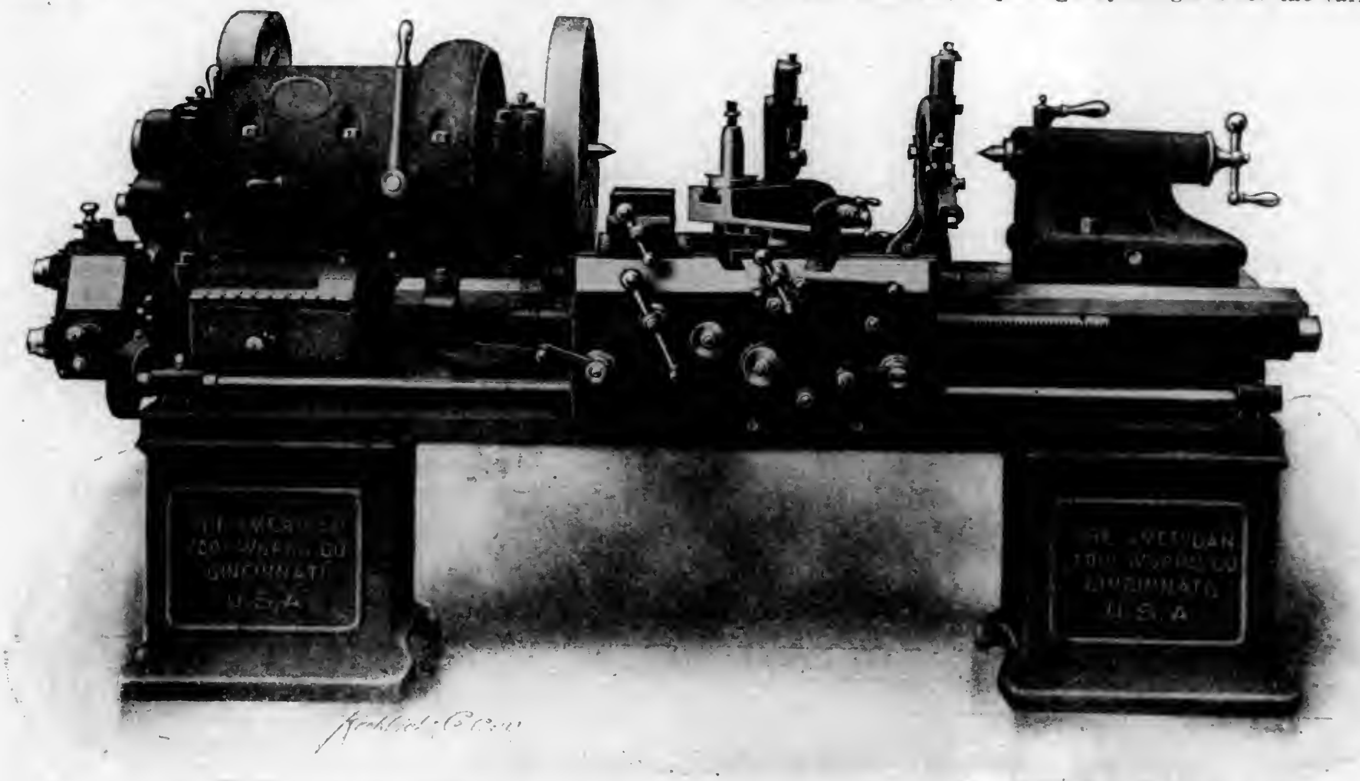
It is built by the Royersford Foundry and Machine Company, of Royersford, Pa., who build a large range of sizes of punch and shearing machines, combined and single end, and for almost all purposes, including railroad shop, locomotive and car building and general machine shop work.

GEARED VARIABLE-SPEED DRIVE FOR THE "AMERICAN" LATHE.

The American Tool Works Company.

In view of the marked tendency in modern shop practice toward all-gear drives for machine tools, the lathe shown in the accompanying illustration will be of special interest to all who are concerned with the use of machine tools. It shows the American lathe, built by The American Tool Works Co., Cincinnati, O., with a new friction all-geared head, designed for direct connection to an electric motor.

The headstock is, in this case, built as a complete unit to which any type of motor, constant or variable-speed, may be readily connected, the motor being set on top, or at the rear of the gear casing. The mechanical speed changing device is simple and powerful, requiring only six gears for the various



NEW DESIGN OF LATHE WITH GEARED VARIABLE-SPEED HEADSTOCK DRIVE.—AMERICAN TOOL WORKS COMPANY.

The latter cross slide adjustment is clearly shown in the engraving; it is operated by the handle shown carrying a pinion which meshes with a rack cut on the edge of the cross slide.

In mounting the mechanism, it is clamped in the tool block with a shoulder on the bracket base snug against one side of the tool block which brings the cross slide on a line exactly 30 degrees from the lathe spindle center. Then the endless belts are slipped on their pulleys, and the tool is ready for use; this entire operation requires but a few moments.

The spindle that carries the emery wheel is ground taper, having provision for taking up wear, and also has a dust cap for protection from grit. The speed ratio from the chuck-driving pulley to the grinder spindle is such that the grinding wheel will make 1,600 rev. per min., when the lathe spindle speed is 250 rev. per min. An important feature of this tool is the fact that any twisting of belts is rendered entirely unnecessary.

This tool is also applicable to other kinds of light circular grinding by placing a driving drum overhead the lathe, for which many uses may be found for it. It also is provided with a small rest, as shown at the left of the emery wheel, which is particularly convenient for sharpening cutters, drills and light work.

A NEW LOCOMOTIVE FRAME DRILL.

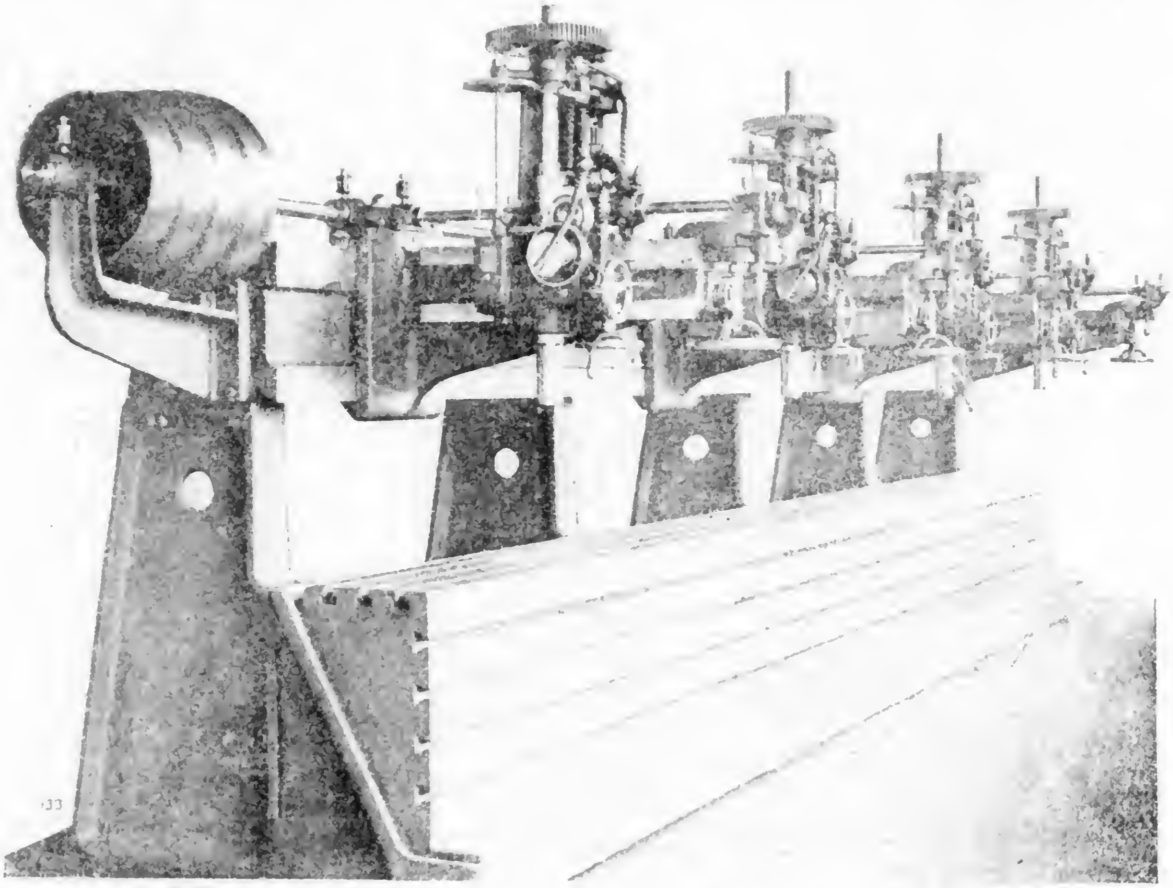
BICKFORD DRILL AND TOOL COMPANY.

The multiple-spindle drill illustrated in the accompanying engraving is an interesting new design of drilling machine that has recently been developed especially for use in drilling locomotive frames. It departs from the usual practice in this class of machinery in several features which tend to facilitate operations upon the tool and add convenience to its manipulation. It was designed and built by The Bickford Drill and Tool Company, Cincinnati, Ohio, from specifications submitted by the Locomotive and Machine Company, Montreal, Canada, and is to be used at the new shops of the latter company for drilling, reaming and tapping the sides and edges of locomotive frames of sizes up to 27 ft. 3 ins. between holes.

The tool is built with four projecting arms, arranged upon a cross rail, of stiff construction and well supported. The arm at the right-hand end is arranged to rotate through an angle of 30 degrees. The arms are made in pipe section, the usual Bickford construction, and are adjustable on the rail either by hand or power.

The spindles have eight changes of speed, ranging in geometrical progression from 19 to 120 revolutions per minute, and are provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gauge, and hand lever reverse. The back gears are located on the head, bringing the power direct to the work, and may be engaged, disengaged, or thrown out of service while the machine is running, and the operator is not obliged to reach the shifter in order to stop the spindle.

The depth gauge answers a double purpose in this application; besides enabling the operator to read all depths from zero (which does away with the usual delays concomitant to scaling or calipering), it also supplies a convenient means for setting the automatic trip, the graduations showing exactly where each dog should be set in order to disengage the feed at the desired points.



FOUR-SPINDLE LOCOMOTIVE FRAME DRILL OF NEW DESIGN.—BICKFORD DRILL AND TOOL COMPANY.

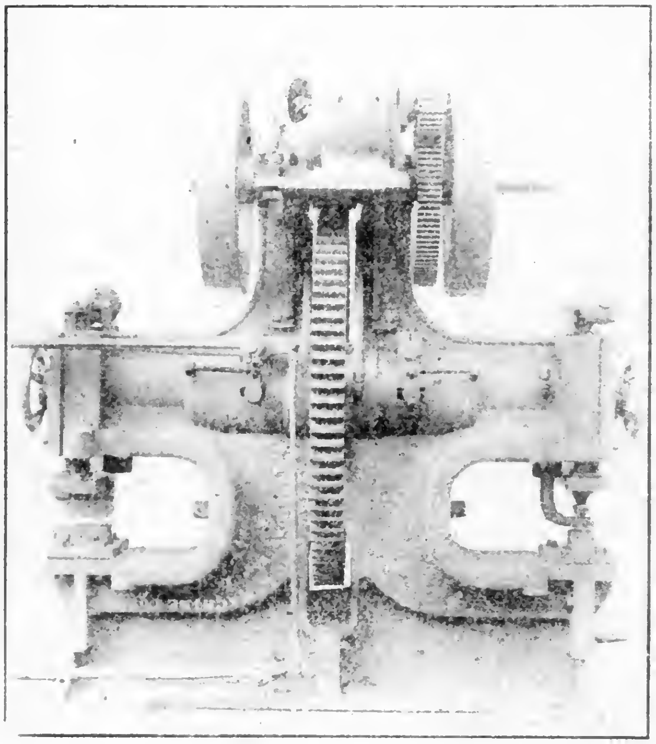
The feeding mechanism furnishes eight rates of feed, ranging in geometrical progression from .007 in. to .064 in. per revolution of spindle, each of which is instantly available, eliminating all loss of time incident to shifting a belt. An engraved plate attached to the head shows the operator how to obtain each of the feeds. The tapping mechanisms are located on the heads, and are fitted with friction clutches operated by levers the handles of which extend around under the arms within convenient reach of the operator.

The spindles are 2½ ins. in diameter, have a vertical adjustment of 17 ins., and operate over an area of 2 ft. 4 ins. x 27 ft. 3 ins. The table has a width of 18 ins., a height of 30 ins. and a length of 29 ft. The machine weighes 49,000 lbs., and is designed to be driven by a 5-in. high speed double belt.

A MODERN DESIGN OF ELECTRICALLY DRIVEN COMBINED PUNCH AND SHEAR.

ROYERSFORD FOUNDRY AND MACHINE CO.

The tool illustrated in the accompanying engraving is an interesting application of motor driving to the requirements of modern punching and shearing machinery service. The design of this machine is extremely heavy, and in the effort used to bring the construction up to modern requirements, the ordinary standards have been greatly surpassed in this design.



THE ROYERSFORD MOTOR-DRIVEN COMBINED PUNCH AND SHEAR.

Exceptional fly-wheel capacity has been provided to store up a large surplus of energy between strokes for driving at instants of punching or shearing. It will be noticed that the fly-wheels are located close together, and as the shaft is very short, and also of large diameter, there is little chance for torsion or spring in the shaft. This is an important feature in connection with a punch or shearing machine.

The drive is furnished by a 5 h.p. constant-speed direct-current motor, built by the Crocker-Wheeler Company, Ampere, N. J., which drives the cast steel gear on the fly-wheel shaft through a rawhide pinion on the armature shaft. The gear ratios are such as to bring the proper fly-wheel speed, for which the machine was designed, directly. This style of drive is very convenient and neat, requiring no extra floor space and also keeping the motor up out of the way of harm.

This machine has an 18 in. throat on both sides, and has a shearing capacity of 6 ins. x ¾ in. flat and 1¼ ins. round iron and a punching capacity of 1 in. hole through ⅝-in. iron plate. It will also be noticed that the punch side is provided with a removable lower jaw, which makes it desirable for punching I-beams and channels. This makes an ideal machine for punch and shear work of modern requirements. The eccentric shaft is of steel and of a large diameter, giving ample wearing surface. The eccentric boxes are made of phosphorus bronze.

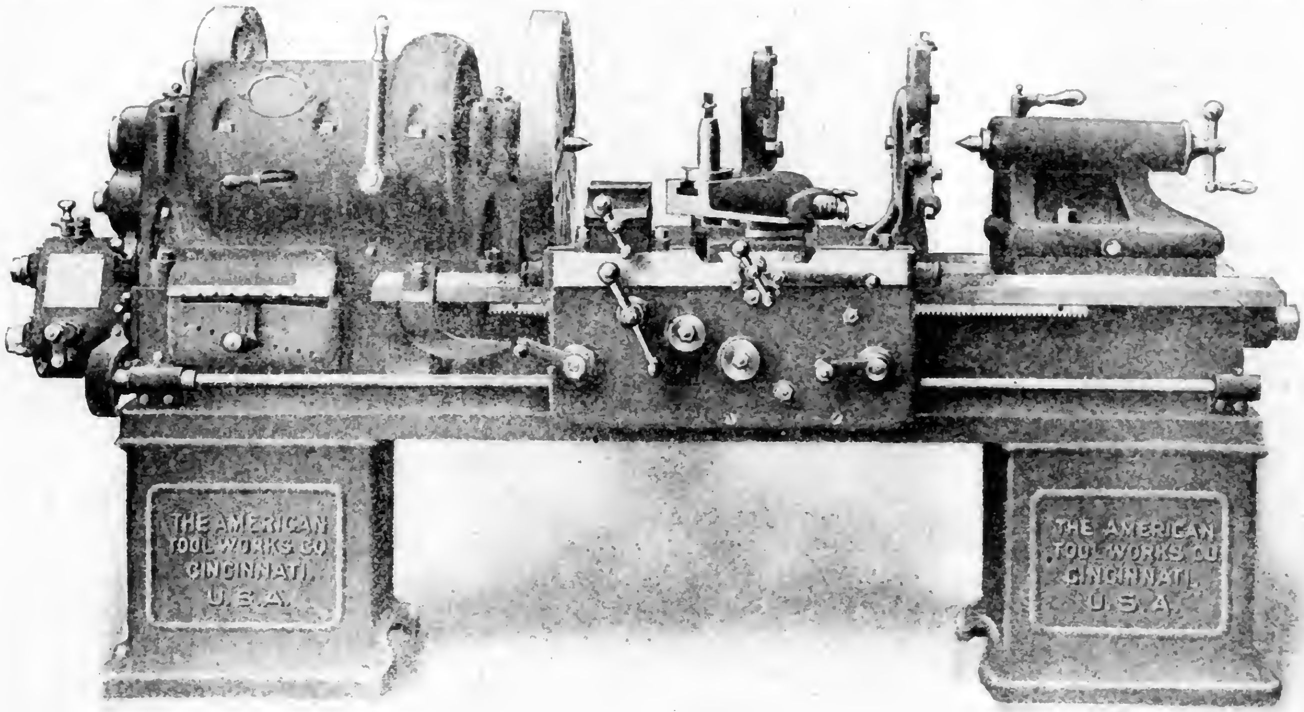
It is built by the Royersford Foundry and Machine Company, of Royersford, Pa., who build a large range of sizes of punch and shearing machines, combined and single end, and for almost all purposes, including railroad shop, locomotive and car building and general machine shop work.

GEARED VARIABLE-SPEED DRIVE FOR THE "AMERICAN" LATHE.

THE AMERICAN TOOL WORKS COMPANY.

In view of the marked tendency in modern shop practice toward all-gear drives for machine tools, the lathe shown in the accompanying illustration will be of special interest to all who are concerned with the use of machine tools. It shows the American lathe, built by The American Tool Works Co., Cincinnati, O., with a new friction all-geared head, designed for direct connection to an electric motor.

The headstock is, in this case, built as a complete unit to which any type of motor, constant or variable-speed, may be readily connected, the motor being set on top, or at the rear of the gear casing. The mechanical speed changing device is simple and powerful, requiring only six gears for the various



NEW DESIGN OF LATHE WITH GEARED VARIABLE-SPEED HEADSTOCK DRIVE.—AMERICAN TOOL WORKS COMPANY.

changes of spindle speeds. It has a very few parts and less gears than any other similar device. All the gearing and mechanism are neatly and completely housed in, and the gears are arranged to run at very low pitch line velocities, reducing to a minimum the noise incidental to all-gear drives. Friction clutches are used throughout, thus avoiding the necessity of slip gears, pull pins, hollow shafts, tumbler gears or complicated and frail parts.

This construction, in connection with a fifteen-speed motor, was made to provide sixty spindle speeds on the 20-inch lathe, ranging from 5 to 322 rev. per min., in geometrical progression, all of which are instantly and easily obtainable while the tool is in operation; the motor controller lever is located on the right hand side of the apron convenient to the hand of the operator. This speed-changing mechanism is also adaptable to belt driving from a countershaft, as in the illustration; it also has the advantage that the great flexibility of this construction will permit a machine thus installed as a belt-driven lathe to be readily converted into a motor-driven lathe at any future time.

This new design of lathe is unquestionably a step in the right direction as the general trend of machine tool progress points toward the use of machines with variable-speed driving mechanisms. The advantages offered by the geared variable-speed drive are incomparably greater than the antiquated cone pulley and belt drive. Especially is this gear mechanism of advantage in connection with motor driving; with constant-speed motors a convenient range of speeds is provided, while in applying a variable-speed motor, the speed range in the motor may be greatly reduced, without sacrificing the resultant range at the lathe spindle—this permits a much smaller motor to be used. The American Tool Works Company are to be commended for bringing out this design.

VIBRATION TEST OF STAYBOLT IRON.

Last August the Grand Trunk Railway conducted some vibratory tests on a number of staybolt irons by different makers, with a view of reproducing in severer form the vibrations to which staybolts are subjected in locomotive boilers. The vibrations were produced at a rate of 32 per minute. The results, which are received from the Falls Hollow Staybolt Company, are as follows:

	Size.	Duration.	Broke on
Falls hollow charcoal iron.........	1 in.	157 mins.	5,024 vibrations
Falls solid charcoal iron...........	1 in.	131 mins.	4,192 vibrations
"B" iron	1 in.	75 mins.	2,400 vibrations
"C" iron	1 in.	75 mins.	2,400 vibrations
"D" iron	1 in.	85 mins.	2,635 vibrations
"E" iron	7/8 in.	120 mins.	3,840 vibrations
"F" iron	1 in.	95 mins.	3,040 vibrations

The actual duration of the Falls hollow charcoal iron was 161 mins., equal to 5,192 vibrations, but the resistant strength of the sample caused intermittent attention by the tester, with wooden wedges to keep the sample taut, and for this 4 mins. were deducted.

EQUIPMENT AND MANUFACTURING NOTES.

A centrifugal pump of novel design and unprecedented capabilities will be exhibited at the St. Louis Exposition by Henry R. Worthington, of New York City. That this pump marks a distinct departure from the usual centrifugal practice will be appreciated when it is stated that it will be capable of delivering about 500 gals. of water per minute against a head of 250 lbs. per square inch, and with high efficiency. This pump is of the type known as the multi-stage, turbine centrifugal, and differs in a great many respects from the centrifugal pumps with which engineers have been familiar.

Work is fast nearing completion upon the new power plant of the B. F. Sturtevant Company at Hyde Park, Mass. This bids fair to be one of the most complete plants of its kind in the country, special care having been taken in connection with every detail to secure the highest efficiency and the most modern equipment. The plant will comprise four water tube boilers, with stokers supplied by forced draft, an economizer with induced draft, and a complete outfit of generating sets, all of the Sturtevant make, together with condenser, air compressor, etc. The Sturtevant exhaust head is also used for separating the water and oil from the exhaust steam from the engines.

The Kennicott Water Softener Company have established an office at 29 Great Saint Helens, London, E. C., England.

Mr. Irving H. Reynolds will soon retire from the Allis-Chalmers Company and the duties of chief engineer will be assumed by the engineers in charge of the various departments, these engineers availing themselves of the advice of Mr. Edwin Reynolds, consulting engineer of the company.

Messrs. Pedrick & Ayer, Plainfield, N. J., announce the appointment of Mr. R. O. Cumback as superintendent of their plant at that point. He has for several years been connected with the motive power department of the Central Railroad of New Jersey at the Elizabethport shops.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, have recently doubled the capacity of their works for the manufacture of their double refined, charcoal iron, hollow and solid staybolt material. They have also added a 50 by 200 ft. extension to their buildings for increase of storage capacity for raw material and manufactured product.

The Washburn Company, of Minneapolis, Minn., announce that they have made arrangements with the Pennsylvania Malleable Company, of Pittsburgh, Pa., to manufacture and sell all their different types of couplers in the Central, Eastern and New England States. The Washburn Company will continue the sale and manufacture in other parts of the country.

Riehle Bros. Testing Machine Company, 1424 North Ninth street, Philadelphia, Pa., announce that because their catalogues have become too bulky for general distribution (the nine catalogues weigh three pounds) they are sending out coupons upon which any desired catalogue may be ordered, whereupon it will be promptly sent by mail. These pamphlets are described in folders which are issued with the coupons.

Wm. B. Scaife & Sons Company, of Pittsburgh, Pa., manufacturers of the Scaife and We-Fu-Go Systems for softening and purifying water, have appointed Mr. C. A. Malau, of the City of Mexico, their sole representative in that Republic for the sale of their various systems for this purpose. This company is now manufacturing several types of water purifying systems; intermittent or continuous; treating the water either hot or cold. They have had an extensive experience in this line, and are prepared to carry out any kind of water purification which they undertake. They report that they are now softening and purifying 350,000,000 gals. of water daily for steam boilers and other industries where pure soft water is desirable with their various systems. Mr. Malau is especially well fitted to look after his clients in Mexico, as he is thoroughly acquainted with the engineering and industrial wants of that country, and has devoted considerable attention to the subject of water purification.

From a San Francisco correspondent we learn that at the Nimshew Power House of the Valley Counties Power Company, a sub-company of the California Gas & Electric Corporation, the first two machines have begun operation, feeding into the transmission line of the Bay Counties Power Company. The power house is located in the Butte Creek Canyon, twenty-four miles from Chico. The available total head of water is 1531 feet, taken down in one pipe line 6,200 feet long, and tapering in three sections, from 30 to 28½ inches diameter. Within the power house the pipe terminates in a Y, each branch of the Y supplying a 3,700 h.p. water-wheel, the largest wheels operated as yet by one single jet of water. The generators are of the Stanley Electric Company's make, the rotary element mounted on one single shaft with the water-wheel; the entire hydro-electric unit runs in two bearings, the rotary element of the generator between the bearings, and the water-wheel overhung. The shaft and disc are nickel steel forgings, (the shaft being hollow forged and oil tempered,) made by the Bethlehem Steel Company; and the buckets are steel castings of the patented ellipsoidal type. The total weight of the revolving part of each unit is over forty tons; the speed, 240 rev. per min. Each water-wheel is provided with a Doble patented needle, regulating deflecting nozzle and hydraulically operated piston gate, a Lombard type D governor with electric speed controller, taking care of the sudden fluctuations of the load by deflecting the nozzle, whereas the regulating needle is operated by hand and set according to the average load of the respective hours of the day. The hydraulic machinery, including shaft, bearings and gates, was designed and built by the Abner Doble Company of San Francisco.